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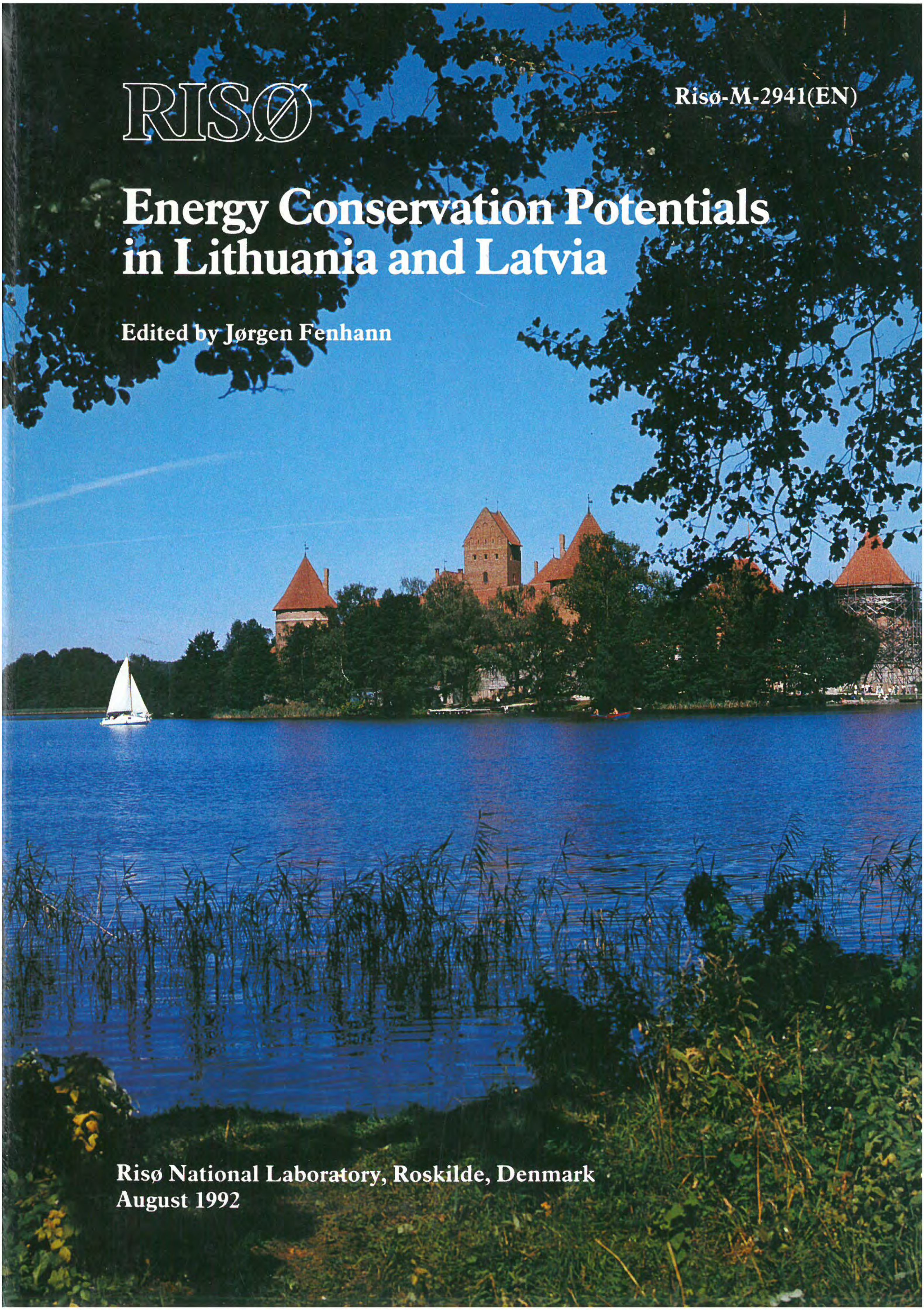
Energy Conservation Potentials in Lithuania and Latvia

Edited by Jørgen Fenhann



Risø National Laboratory, Roskilde, Denmark
August 1992

Energy Conservation Potentials in Lithuania and Latvia

Risø-M-29041(EN)

Edited by Jørgen Fenhann

Risø National Laboratory, Roskilde, Denmark
August 1992

Abstract This is the third report in a series of reports about the energy systems in the Baltic countries: Estonia, Latvia and Lithuania from the project »Baltic-Nordic cooperation in the field of energy and environment« financed by the Energy Market Group under the Nordic Council of Ministers.

The present report tries to illustrate the potentials for energy conservation in Lithuania and Latvia.

For Lithuania the material is based on the »National energy efficiency programme«, which was prepared in 1991. It documents that the energy conservation potentials are large, especially in the heating sector. In includes the views of the Lithuantan specialists of the best measures and strategic directions to restructure the energy system.

For Latvia similar material is not available but will be developed in the tasks described in the National Energy Saving Strategy which the Government has established. This strategy is described and thoughts about future developments had to be based on energy projections from 1990 which although they are rather high still reflects some of the future possibilities including a calculation of the energy saving potentials, also made in 1990. The section about Latvia also contain chapters of the wood, straw and peat resources.

Front cover: The Trakai castle, which was built in the 15th century.
Back cover : The heating installation in the castle.

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Contents

Preface

Since the three Baltic countries got their independance there has been a rapidly growing interest in the reconstruction of their energy systems.

This report is the third in a series of studies financed by the Energy Market Group under the Nordic Council of Ministers.

The project was carried out in a collaboration between

Jørgen Fenhann (project leader)
Systems Analysis Department
Risø National Laboratory, Denmark

and

Ilka Savolainen
Markus Tähtinen
Technical Research Center of Finland (VTT)
Helsinki, Finland.

The first report was published by Jørgen Fenhann at Risø in August 1991 (1. edition) and January 1992 (2. edition) with the title:

Energy and Environment in Estonia,
Latvia and Lithuania
Risø-M-2943 (ed. 2)(EN)

The second report only about Estonia was published in the spring 1992 by Markus Tähtinen at VTT together with Heinar Nurste from EnPro Engineers Bureau Ltd. in Tallinn, Estonia (formerly at the Institute of Thermophysics and Electrophysics in Tallinn) with the title:

Energy use and emission scenarios to the year 2000 for Estonia
VTT Research Notes 134
Technical Research Centre of Finland
Espoo, Finland.

This report thus covers Lithuania and Latvia.

The Lithuanian part is a shortened and generalized version of the National Energy Efficiency Programme. Additional information is available from:

1) on energy technologies and general questions concerning energy conservation - Prof. Matas Tamonis
2) on economical instruments and economic evaluations - Dr. Valentinas Klevas
3) on energy consumption and energy demand forecasting - Dr. Vidmantas Jankauskas

all from

Lithuanian Energy Institute
Aukštadvario Str. 3
3035 Kaunas, Lithuania
Fax 7-0127-751271

On restructuring the building materials and construction industries - Dr. Vytautas Barkauskas, Institute of Architecture and Construction, Barsausko Str. 60, 3035 Kaunas.

The Latvian part was prepared in collaboration with Dr. Peteris Shipkovs and Dr. Viktors Zebergs both from

Institute of Physical Energetics
Aizkraukles Street 21
226006 Riga, Latvia.

We are greatful for the great effort from the people mentioned above and for the great hospitality of their institutions.

Jørgen Fenhann
September 1992

Introduction

At the moment the Baltic countries is in the process of a profound structural transformation.

The energy sector is crucial to the restructuring of the societies.

The historie dependency on the USSR as a single foreign fuel supplier together with the increasingly difficult supply situation in the former USSR and the requirement now to pay for fuels in hard currency has created a severe supply situation.

The energy sector has, like many other sectors, to be totally changed. Fundamental changes of the social and economical conditions after the Baltic countries got their independence present new priorities and possibilities for the development of their energy systems. Until now they were developed according to plans of central departments and was treated as an inseparable part of the Soviet electricity and fuel complex. The development of their energy systems was based on common benefits of the USSR, according to Soviet political and administrative standards, rules and laws rather than commercial factors. Seemingly inexhaustible cheap energy resources along with central planning produced many of the negative properties of the existing energy system. The absence of market signals promoted great inefficiency in both production and consumption of energy with severe environmental consequences including problems of nuclear safety.

The problems are revealed most clearly in the heat supply and consumption systems. The district heating systems are poorly insulated, not flexible, insufficient controlled, with long distances of supply, with often breaks of pipes and other disruptions of supply. Customers have no possibilities for regulation and no metering devices. As a rule, private dwellings, public houses and industrial buildings have very low thermal resistance. The majority of heat consumers not connected to district heating systems are forced to burn solid fuel in old inefficient, highly polluting boilers and furnaces. This part of the energy system may be very costly to retrofit, but on the other hand, here is also the largest energy saving potential. One should not have illusion to reduce the heat consumption rapidly.

The total consumption of primary energy has decreased since 1989. In Lithuania by 25% from 1989 to 1992. The reason is the economical recission and the main part of the reduction is in the energy intensive industries. With privatization and restructuring of industry the present obsolete technologies will be changed and energy consumption in industry will be reduced to a lower fraction of the total energy consumption like in Western Europe.

Earlier energy forecasts also overrated the growth of electricity consumption. Since 1990 e.g. the peak load has dropped in Lithuania. Lithuania at the moment posses an overcapacity of electric power plants but it must be taken into account that the output of the Ignalina nuclear power plant in the future may be limited or even suspended. Latvia has a big capacity problem since it must import a large fraction of its electricity needs.

The drastic changes makes energy planning extremely difficult at the moment. No such plans or reliable projections of the future energy consumption exist at the moment, this makes decisions of construction of new capacities very difficult. The strategic goal it such a situation is to apply the great potentials for energy conservation and to investigate the possibilities for development of interconnecting links to NORDEL, shifting demands away from peak hours and to extend the generating capacities by changing heating plants (boiler houses) to combined heat and power plants.

The present report tries to illustrate some of these possibilities.

For Lithuania the best material was found in the »National energy efficiency programme«, which was prepared in 1991. It documents that the energy conservation potentials are large, especially in the heating sector (see Figure 2.5). It includes the views of the Lithuanian authors of the best measures and strategic directions to restructure the energy system. When looking at the economical calculations in Chapter 2 it is important to remember that the monetary unit is 1989 roubles.

For Latvia similar material is not available but will be developed in the tasks described in the National Energy Saving Strategy which the Government has established. This strategy is described in Chapter 3 together with thoughts about future developments which has to be based on energy projections from 1990 which although they are rather high still reflects some of the future possibilities including a calculation of the energy saving potentials, also made in 1990. The section about Latvia also contain chapters of the wood, straw and peat resources.

With the many energy projects now running/starting in the Baltic countries a clearer and more detailed picture about the energy conservation potentials will soon be available.

2 Energy Conservation Policy in Lithuania

2.1 Foreword

In the »Nacionaline Energijos Vartojimo efektyvumo Didinimo Programa« or in English: »National Energy Efficiency Programme« the present state of the Lithuanian energy system is reviewed. A system of means for its reorganization that will enable it to meet heat and electricity demand under various circumstances and to develop towards an increased energy efficiency is proposed. This programme was prepared by the Ministry of Energy under the state charge No. 8-13387 from September 14, 1990.

In the programme it was proposed to reform the Lithuanian energy system by increasing the efficiency of energy consumption (efficiency was understood in a wide sense as an optimization of total expenditures in energy production, transportation and consumption without reduction of the national income). Changes in the structure of the national economy were also evaluated from the point of view of energy efficiency. Under these preconditions a system of measures for increasing efficiency of energy consumption in the Lithuanian national economy was proposed, as also the legislative and economic measures for their implementation.

The analysis show, that the main reasons for inefficient energy consumption are lack of means for energy metering and regulation, detrimental pricing policy and centralization of energy production. An efficient energy consumption pattern is only possible with a major reorganization of the energy system strategic development, building on energy conservation, with development of a programme orientated towards efficient energy production, distribution and consumption in the total energy system. A background for realization of the proposed programme is a legislative and economical mechanism planned for a long period. The main points are changes in the investments and pricing policy, step-by-step transition of the energy systems to market relations.

The present chapter is a shortened and generalized version of the »National Energy Efficiency Programme«, prepared at the end of 1991.

2.2 State of Energy Consumption and Production

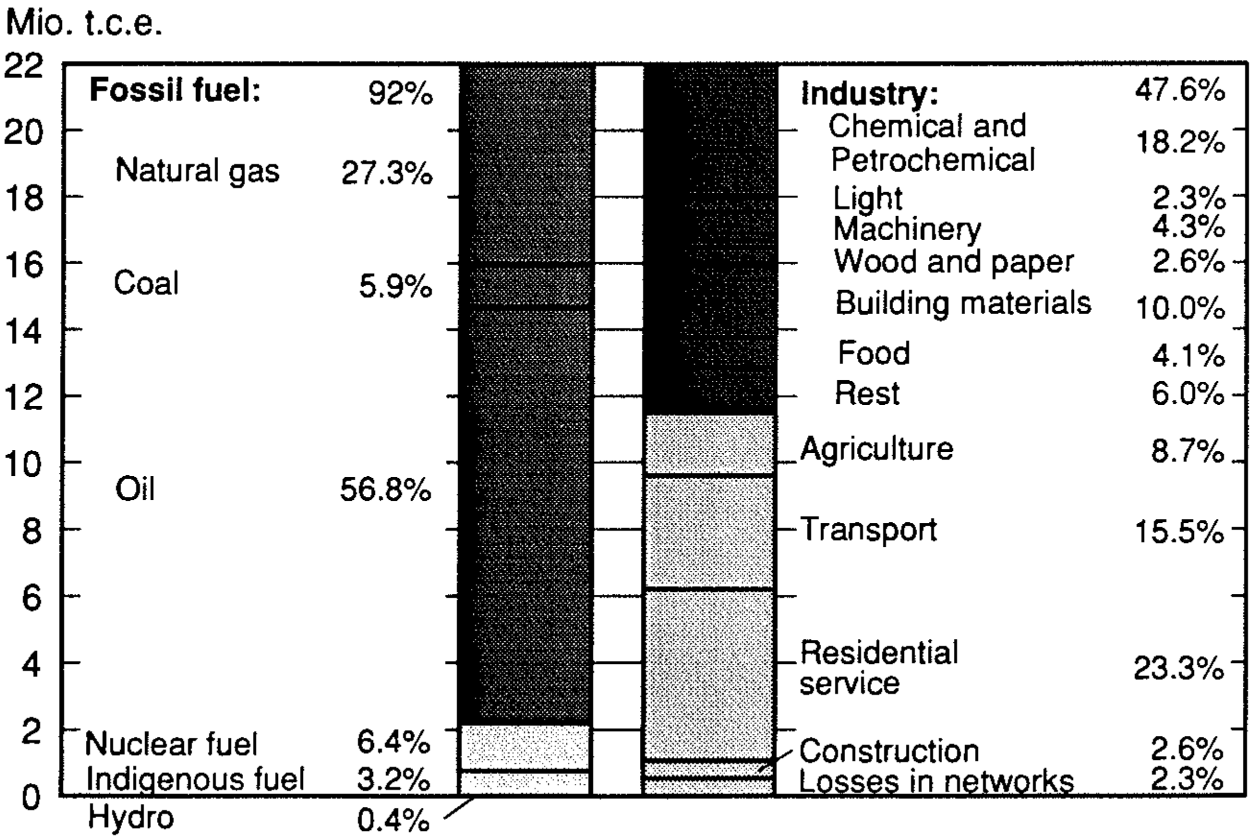
2.2.1 State of Energy Production

In 1989 Lithuania consumed about 22 million tons of coal equivalent, importing 96.4% of the primary resources. The structure of the energy supply is shown in Figure 2.1. Such a budget of primary energy resources is caused by a systematically centralization policy. As a consequence of this policy the share of indigenous fuel decreased to 3.2%, almost all equipment for indigenous or imported solid fuel burning was eliminated.

In 1989 in Lithuania were produced 29.2 TWh of electricity, the main producers were Ignalina nuclear power plant (47.6%) and Elektrenai thermopower plant (34.5%).

Lithuania almost without energy resources is producing twice as much of power as it consumes itself, (12 TWh of electricity was exported in 1989). It causes a great harm to the environment and with an increasing fossil fuel shortage and the lack of real energy and fuel prices it has a negative impact on the national economy.

Figure 2.1. Structure of energy supply and consumption (in 1989).



Though the Lithuanian power system worked rather well, its technological state isn't good. The energy system without cleaning equipment for effluent gases is one of the main polluters of the atmospheric air. The main power plant Elektrenai is almost worn out and large capital investments for its renovation are needed. Contemporary electricity consumers demand a reliable power supply and high electricity quality, so there is lack of an effective reserve of capacity.

Losses in the power system grid in 1990 were 1.6 TWh, hereof in the 330 kV grid - 26.2%, in the 110 kV grid - 33.5% and in the 35-10-0.4 kV grids - 40.3%. Significant losses are caused by the power export to the neighbour countries.

In the biggest towns of Lithuania heat is supplied mostly via the district heating systems, it causes not only large expenditures for renovation and development of the heat transmission and distribution systems but also serious losses of heat in the pipe distribution network. The main heat suppliers now are the »Lithuanian Energy System« supplying 78.5 PJ/year of heat to their customers and the state enterprise »Siluma« supplying 6.9 PJ/year. The total heat losses in the district heating systems are estimated to be roughly 5.5 PJ/year, but because of a bad metering this figure isn't trust-worthy. Losses caused by a bad regulation of consumption are roughly 29.3 PJ/year, that accounts about 40% of total heat produced in the thermal production plants. In an evaluation of losses in the distribution pipes, capital investments and operation expenses for distant consumers, supplied with heat via the district heating systems is unprofitable. Without taking this into account, capacities of power plants and boiler-houses are still enlarged according to the heat supply plans made in 1975-1980. Increase in the length of the pipe distribution networks and prolongation of their operation time cause rather dangerous economical and technical problems.

It's confirmed in Kaunas heat distribution network by pipes breaks during their tests: in 1970 there were 10 cases, in 1975 - 15, in 1980 - 85 and in 1985 even 186, though the test conditions became stronger in the last years. Almost all the distribution pipes constructed before 1975 will reach their critical point (25 years under operation) in year 2000, maintenance and substitution of corroded pipes will be massive.

A more detailed investigation was provided in the Kaunas heat networks enterprise, which enabled an analyse of relations between the economical indicators of the enterprise and characteristics of energy consumption by consumers. Expenditures and capital costs of energy production and distribution were evaluated, as also demand for heat energy, and possible savings in different districts of the town. The large variations of all economical indicators of district heating systems were obtained (Figure 2.2). The variations of unit capital costs, capital cost and heat density in the 12 districts were caused by a different heat density and a distance from a thermal plant. The development of district heating in Kaunas was detrimental even with former low energy prices, while only in one district it was economically (Figure 2.2).

Leaning upon this data one could arrive to the conclusion that heat production and supply in the majority of districts is detrimental. The conclusion may be reinforced with an evaluation of heat losses at consumers. Evaluation of the scale of detrimental heat production and supply enables to prepare the economically based plan of development.

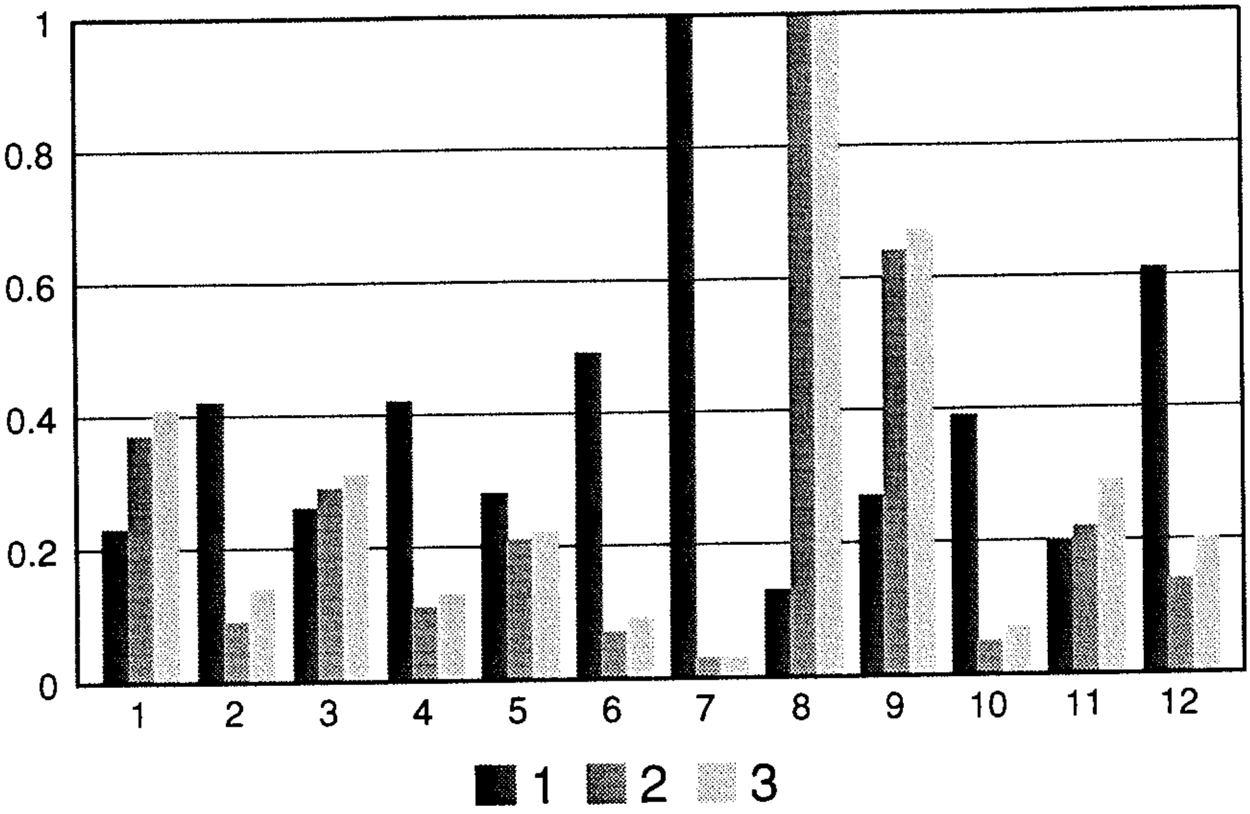
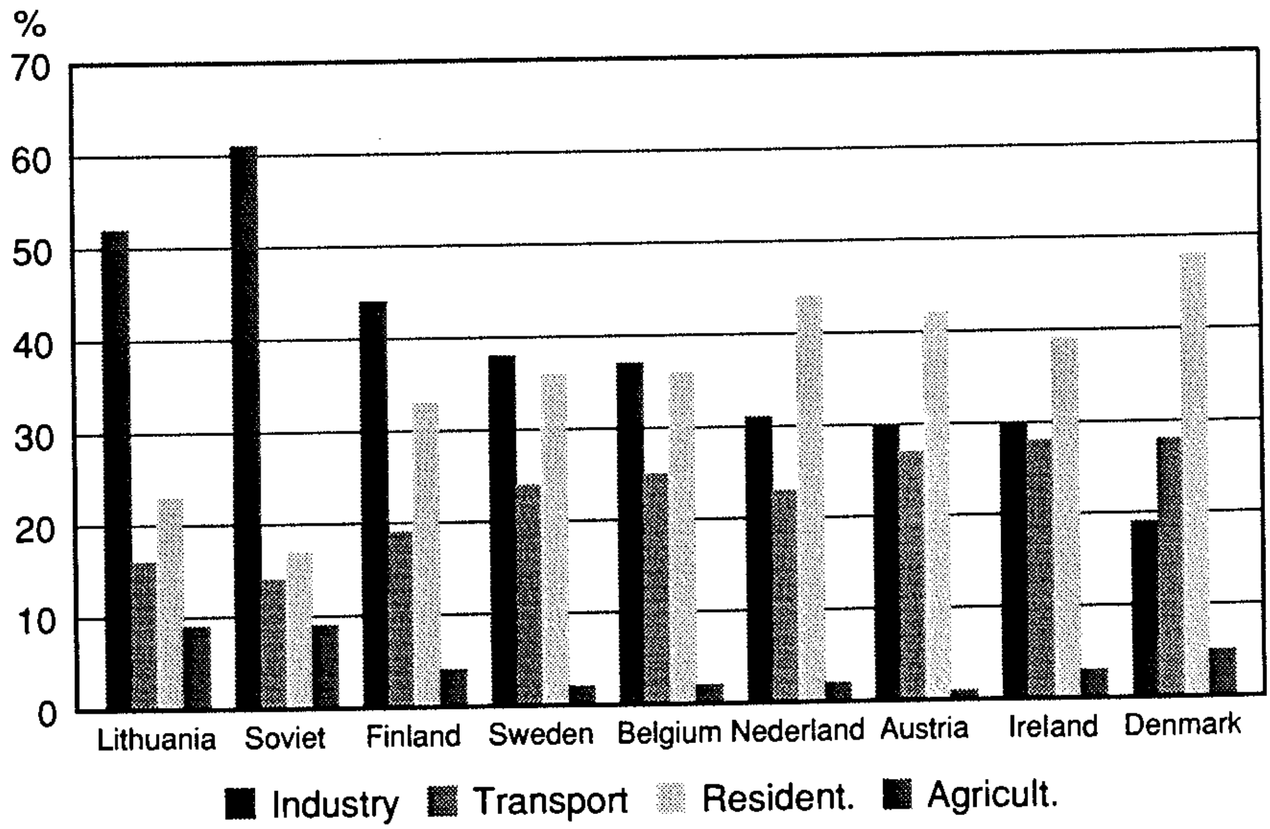


Figure 2.2. Variations of the specific heat density (heat capacity demand per sq. unit, measured in GCal/h/ha) (1), the unit capital cost (2), the unit cost of heat production & transmission (3) (max. values equaled to 1) in various districts of Kaunas.

Figure 2.3. The structure of energy consumption in 1988 in different countries.



2.2.2 State of Energy Consumption

Lithuania in 1990 consumed more than 20 million t.c.e. of primary energy resources per year (Figure 2.1). Energy consumption per capita equals almost to 6 t.c.e. (163 GJ), this indicator is at the level of developed countries. But the structure of the energy consumption in Lithuania differs significantly: industry accounts for about a half of the energy consumed, and the residentials & service sectors - only for 20%. In Western countries the majority of energy resources is consumed in residential and service and in transport, industry accounts from 20% to 40% of the total energy consumption (Figure 2.3).

The analysis show, that we have a huge energy reserve, which equals roughly to one fourth of the total energy resources consumed in Lithuania. Utilization of these reserves should constantly attract the governments attention, because of its large potential.

We'll review in brief the main energy consumers.

The Lithuanian industry is the main energy consumer (Figure 2.1). It consumes about a half of the final energy (in 1989 it was 47.6%, including 48.7% of the total electricity and 54.2% of the total heat, these figures includes losses).

There are two the main high energy consuming industries: the chemical & petrochemical industry and the building materials industry. So Lithuania without indigenous energy resources, with small resources of raw materials, produces the great amounts of cement and mineral fertilizers - high energy consuming products.

The worst is the fact, that a considerable share of industrial products and goods are produced by old technologies, which demand considerably more of energy resources and release more of emission than necessary.

In the last 25 years the electricity consumption in Lithuanian industry increased 5 times, consumption of heat and fuel - 4-5 times, but the shares of these energy forms were rather stable: district heating amounted to more than 40%, - the fuel's share was slightly below 40% and electricity's share - about 20%) (Figure 2.4). At the same time in Western European countries the share of electricity increased significantly (e.g. in Germany almost twice) due to new technologies using the more modern energy form - electricity. It shows a stagnation of our industrial technologies. The same conclusion could be drawed from analysing trends of the specific energy consumption, measured as a final energy consumption per unit of product value. The specific final energy consumption in Lithuanian industry was slowly rising from 1970 to 1985 and decreased only in the last years though this decrease is connected with a rapid inflation.

There are two reasons causing this pattern of energy overconsumption. Our analysis showed that the largest share of energy is wasted in heating and ventilation systems of industrial plants. Losses in these systems, as evaluated, significantly exceed the corresponding systems losses in Western European countries. By putting these systems in order we could reach the level of energy consumption in Western countries without even changing technologies, the total potential amount of energy saved is shown in Figure 2.5.

In **the residential and service sector** only about 45% of fuel is consumed efficiently. The rest are losses, part of them are inevitable (16.5%), the other part is caused by bad constructions of buildings, insufficient heat metering, imperfect regulation and so on.

Such a situation is caused by the investment policy and the corresponding

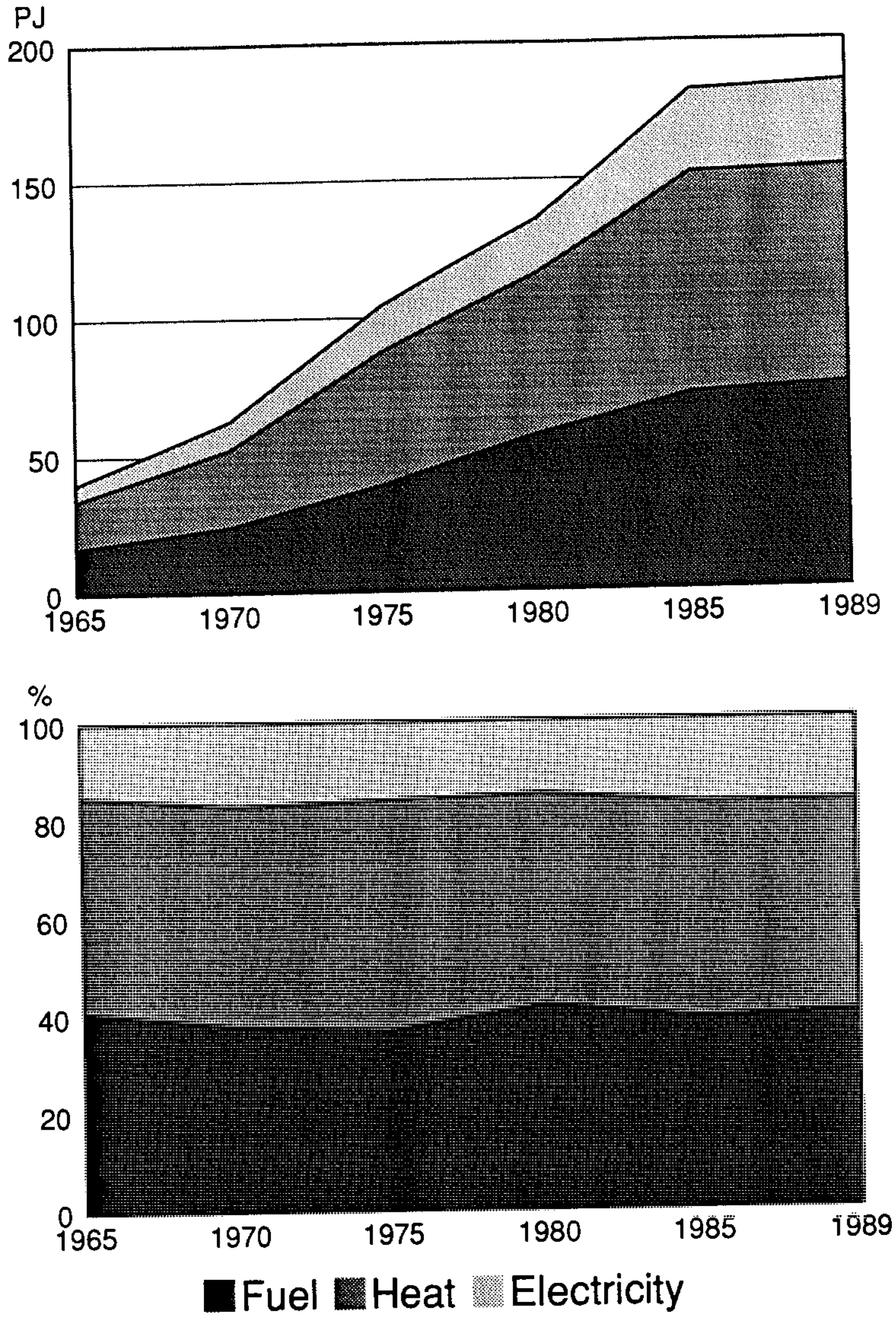


Figure 2.4. Consumption of the final energy in Lithuanian industry.

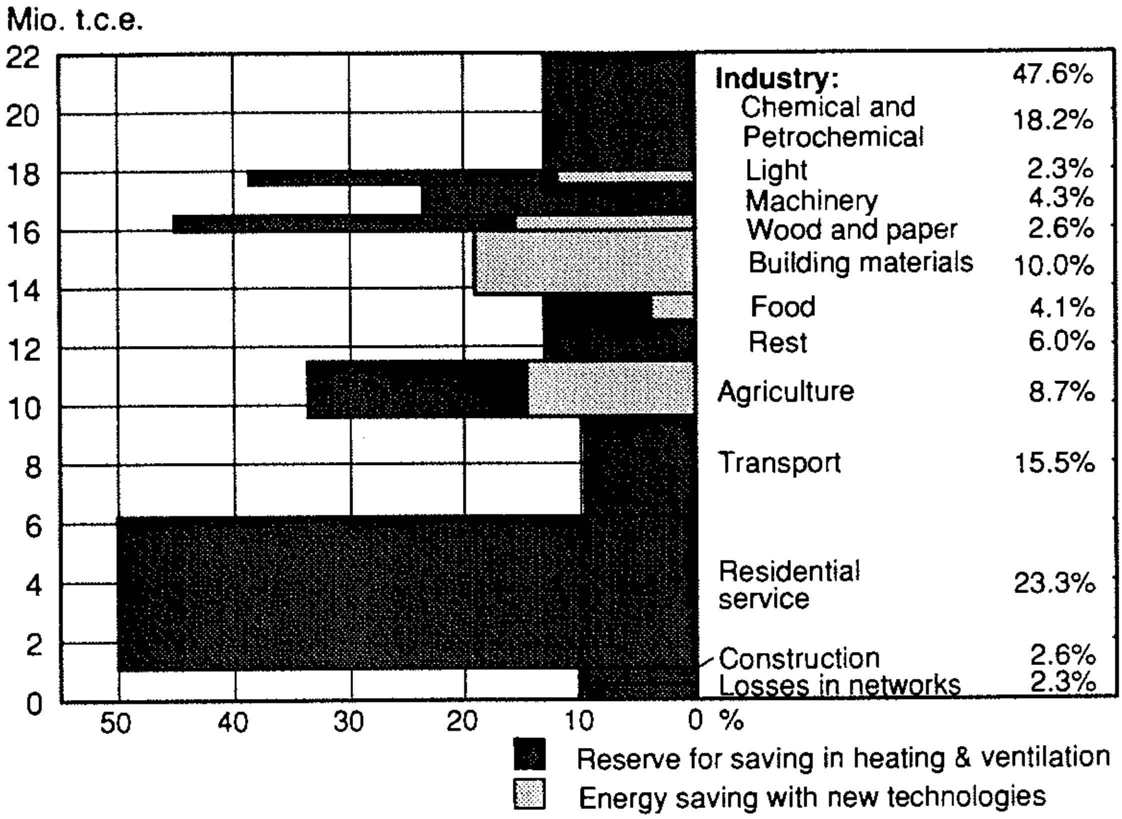


Figure 2.5. Reserves for energy conservation in various sectors of national economy.

legislation for heat supply and consumption which totally ignored the relation between the capital investments and the long period operation expenses. Thus in space heating we consume twice as much of heat than developed countries and even 3 times more than Scandinavian countries (per m^2 of floor area).

The possible energy saving in dwelling houses and municipal, public and agricultural buildings is shown in Figure 2.6.

Thus, **consumption of heat could be at least halved by technical measures and standardization.** Attention may be drawn to the fact, that former GDR have got from the federal government the task to reduce fuel consumption in construction and heating of existing buildings by even higher amounts.

In agriculture the biggest heat losses are in production buildings, the potential for energy saving is about 70% (Figure 2.6), huge amounts of energy are consumed in drying grass, grass seeds, grain, flax and so on. These processes demand 684 GWh of electricity and 120 tousand t.c.e. of fuel. Especially high energy consumption is in the grass flour production: to produce 1 tonne of output we need 180 kWh of electricity and 500 kg c.e. of fuel.

About 50% of the total energy consumption in crops growing goes to the production of mineral fertilizers, and to grass cultivation - about 70-75% goes to fertilizers. The mineral fertilizers consumption increased twice during the last two decades. Production of ammonia fertilizers demands considerably more of energy resources than production of phosphorite or potassium fertilizers. Therefore one could save a lot of energy in the chemical industry with an efficient use of ammonia fertilizers. More attention should be paid on a crop rotation, which enables to enrich soil with nitrogen.

Also in consumption of liquid fuel in the agricultural transport (Figure 2.7)

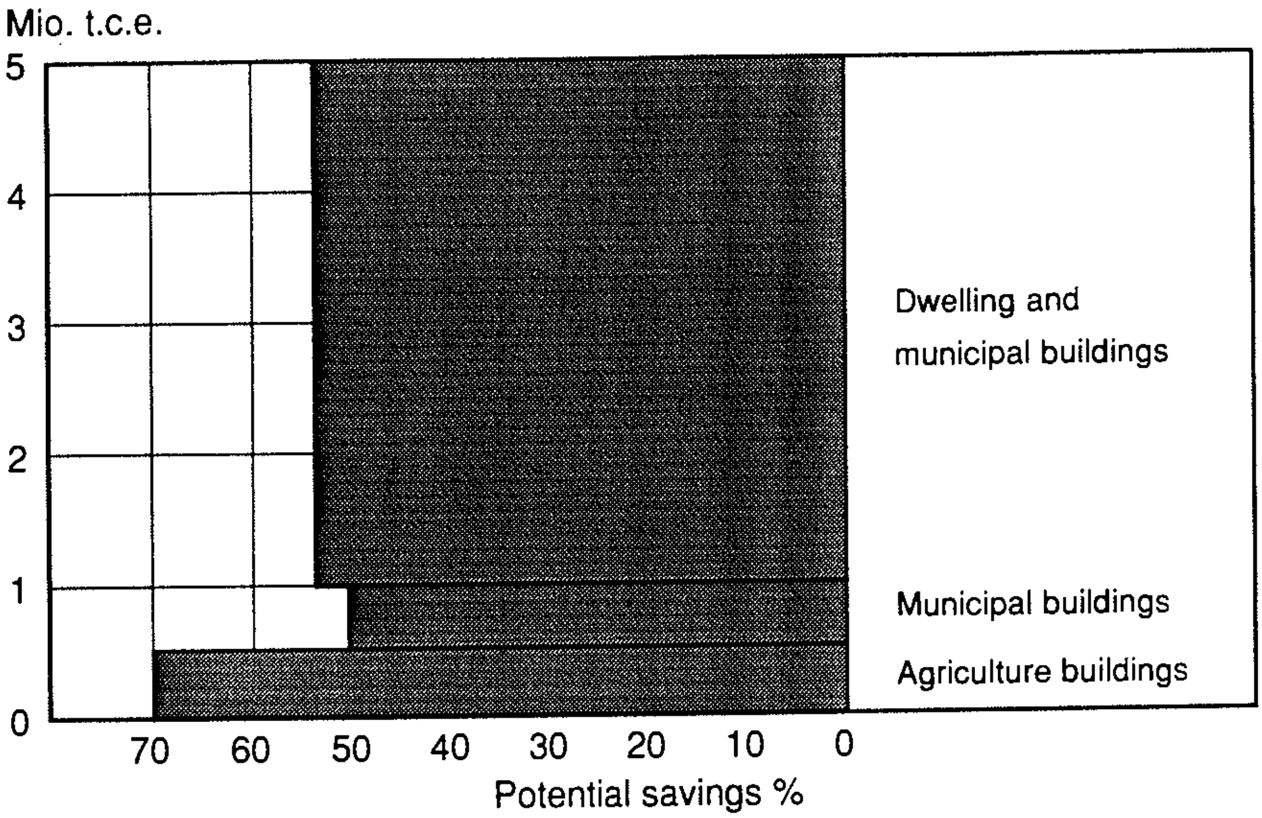
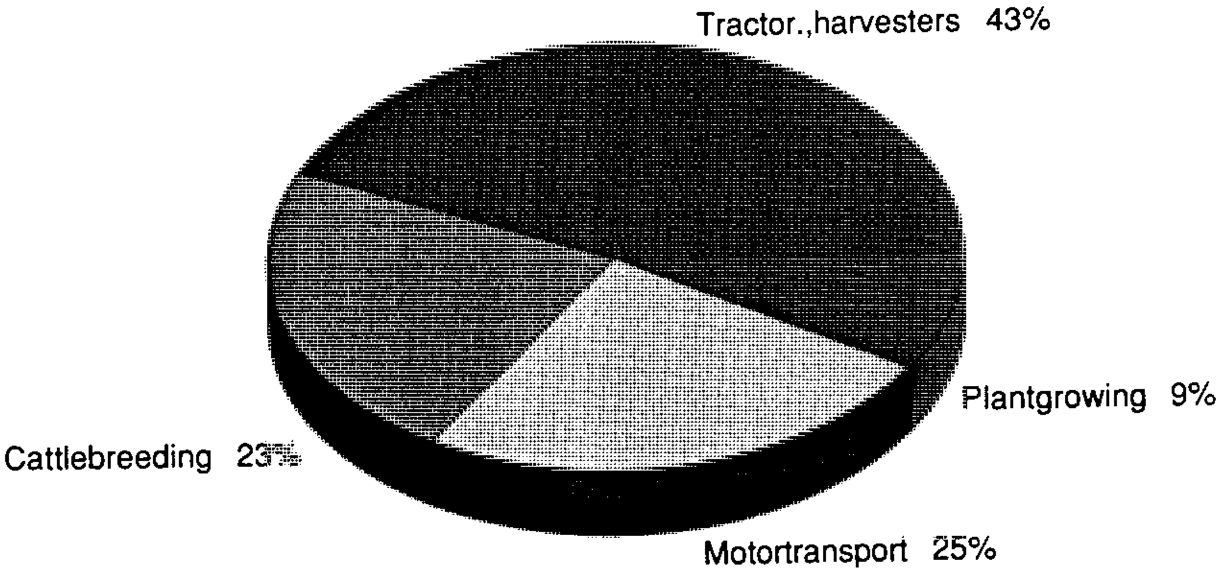


Figure 2.6. Potential for energy conservation in various types of buildings.

Figure 2.7. Consumption of liquid fuel in agriculture in 1989.



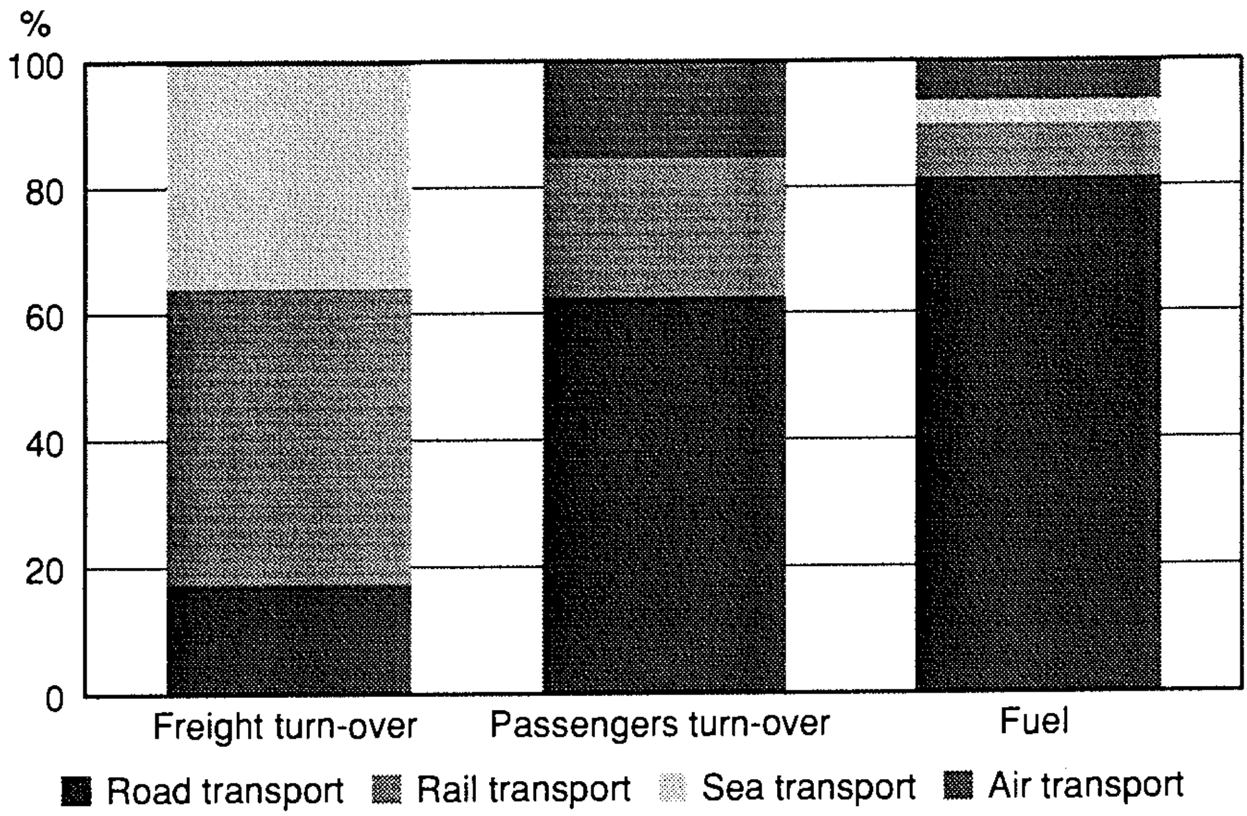


Figure 2.8. Passengers and freight turn-over (pass-km and ton-km) and fuel consumed in the Lithuanian transport (in %).

there is a significant potential for energy saving. The total potential for conservation in agriculture can be estimated to be about 30% (Figure 2.5).

Possibilities for energy conservation in **transport** are similar to other branches of the national economy (Figure 2.5). The main part of the energy savings could be reached in road transport since it consumes 81.5% of the total energy consumed in transport (Figure 2.8). Passengers and goods in Lithuania are transported inefficiently, using not the least energy consuming types of motor vehicles, while an efficient united transport system still isn't created. While railway is the most economical and the least energy consuming transport (Figure 2.8), it is employed inefficiently, and due to a long dependence to the Soviet communication ministry it is lagging behind the material and technical level in Lithuania. The railway network was fitted to cover the former USSR but not Lithuania's needs.

2.2.3 State of Energy Metering

While a flexible tariff system isn't implemented, there is sufficient one tariff electric meters to calculate consumption of electricity. However there is a lack of meters for the inner (department) account, so it is hard to disaggregate energy consumption for different processes and devices, and therefore to apply economical means for energy saving. In Lithuania an informational control and metering systems was invented and produced, its implementation in various industrial plants have started. They aren't able to fulfil regulation function but may be used for inner account in a factory (operating on a self-supporting basis).

Meters of heat consumption is available in the majority of industrial plants and factories, but seldom in the service sector and almost nowhere in administration and public buildings.

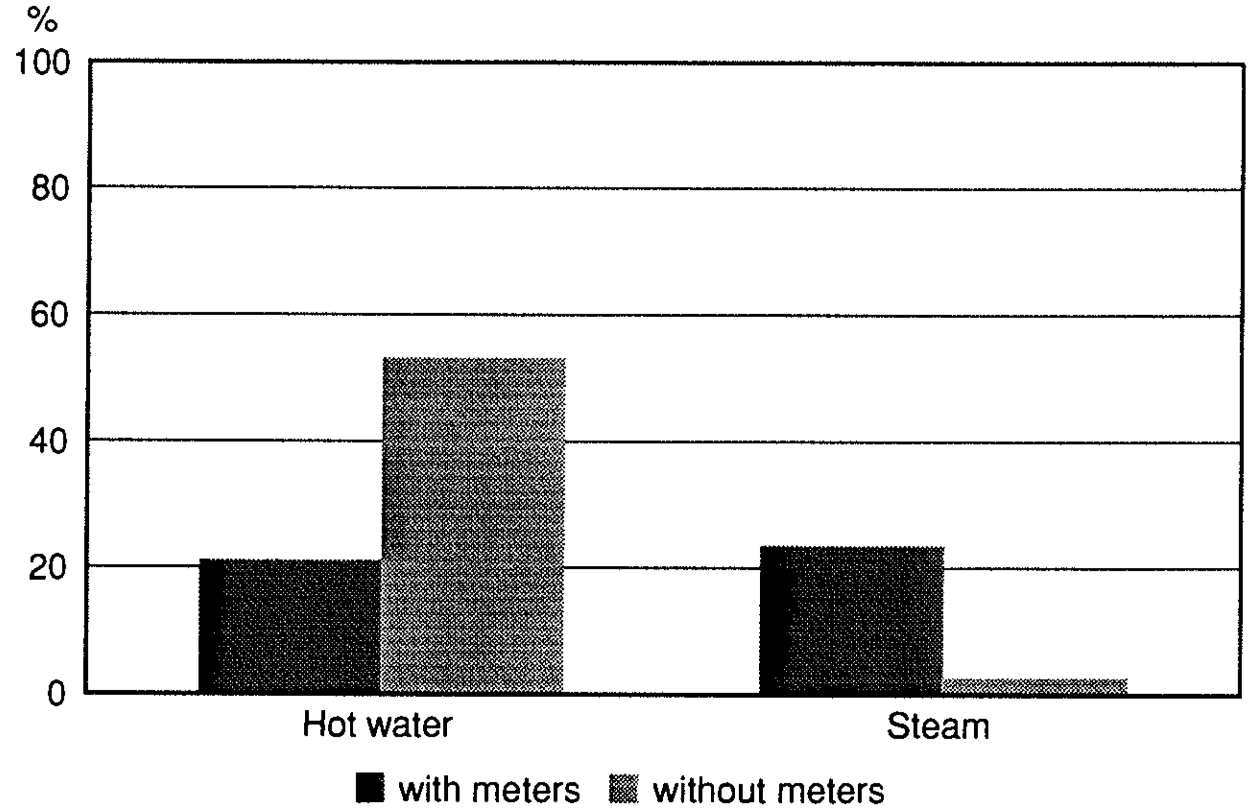
Energy meters for dwelling houses isn't even planned. Some reasons explaining the lack of metering equipment:

- neither suppliers, nor consumers were interested in such an equipment.
- lack of meters and their low quality.
- no meters for dwelling houses at all.

Meters of heat (steam and hot water) are not installed at all industrial plants (Figure 2.9) and insufficiently, especially in different parts of the plants, the consumption regulation equipment is almost totally unavailable.

Metering of the natural gas consumption isn't better. There is gas metering equipment in every gas consuming industrial plant but there is lack of equipment inside the different parts of the plants, especially for boilers in industrial boiler-houses. These boiler-houses are missing various electronic regulators and gas is burned inefficiently. Consumers of natural gas in the residential and service sectors have no metering equipment. It gives background to claim that all the uncontrolled gas losses in the other sectors of the society are added to the consumption of these consumers, this creates uncertainties in the energy balance.

Figure 2.9. Availability of metering equipment for hot water and steam from district heating supply in percentage of total (hotwater + steam).



2.3 Energy Conservation Measures as a New Energy Resource

2.3.1 An Economic Background for Implementation of Energy Metering and Regulation Devices

The most urgent task is to solve the energy metering problem. Without solving it it's impossible to implement the energy conservation measures and to create a suitable economic mechanism. The number of instruments needed given in Table 2.1 shows, that mastering this important task will be complex and rather capital-intensive.

Heat prices raised to the world level hit badly on the urban dwellers connected to district heating systems, as they have no possibilities for energy consumption regulation and have no meters.

One could start with creating a market for metering and regulation equipment. Lithuanian instruments industry should invite Western experience to help, and as fast as possible solve the problem of heat metering and regulation instruments production.

Financing of a massive production of meters and implementation of cheap, efficient regulation devices should start immediately. Some investments should be done immediately to start production of meters or to buy them. The simplest devices should be put into practice first, such as regulators to radiators in heating systems in future buildings as also in existing buildings, or changes requiring no investments such as regulation schedules at the beginning and at the end of every heating season. Without metering and regulation equipment implementation of energy conservation measures is impossible at the consumer side as well as at the producer side. These measures will enable to calculate the real losses in the district heating systems.

Table 2.1.

Destination of the instrument	Number needed in 1000
1. Heat meters of size, including	
a) 100 - 10.000 kW	22-25
b) 30 - 1.000 kW	30-40
c) 3 - 150 kW	80-100
2. Heat meters for individual heaters	1800-2000
3. Cold water consumption meters	700-750*
4. Hot water consumption meters	600-650*
5. Regulators for heating devices	2200
6. Heat regulations	50-60
7. Thermostatic separators of condensate	3
8. Multitariff electric meters	500
9. Automatized energy metering systems	50
10. Devices for automatic control of electric appliances	50-60
11. Gas meters in flats	600
12. Instruments for commercial gas accounting	5

* There are opinions, that it is too expensive to install these meters in every flat in multifamily houses, so their demand could be reduced.

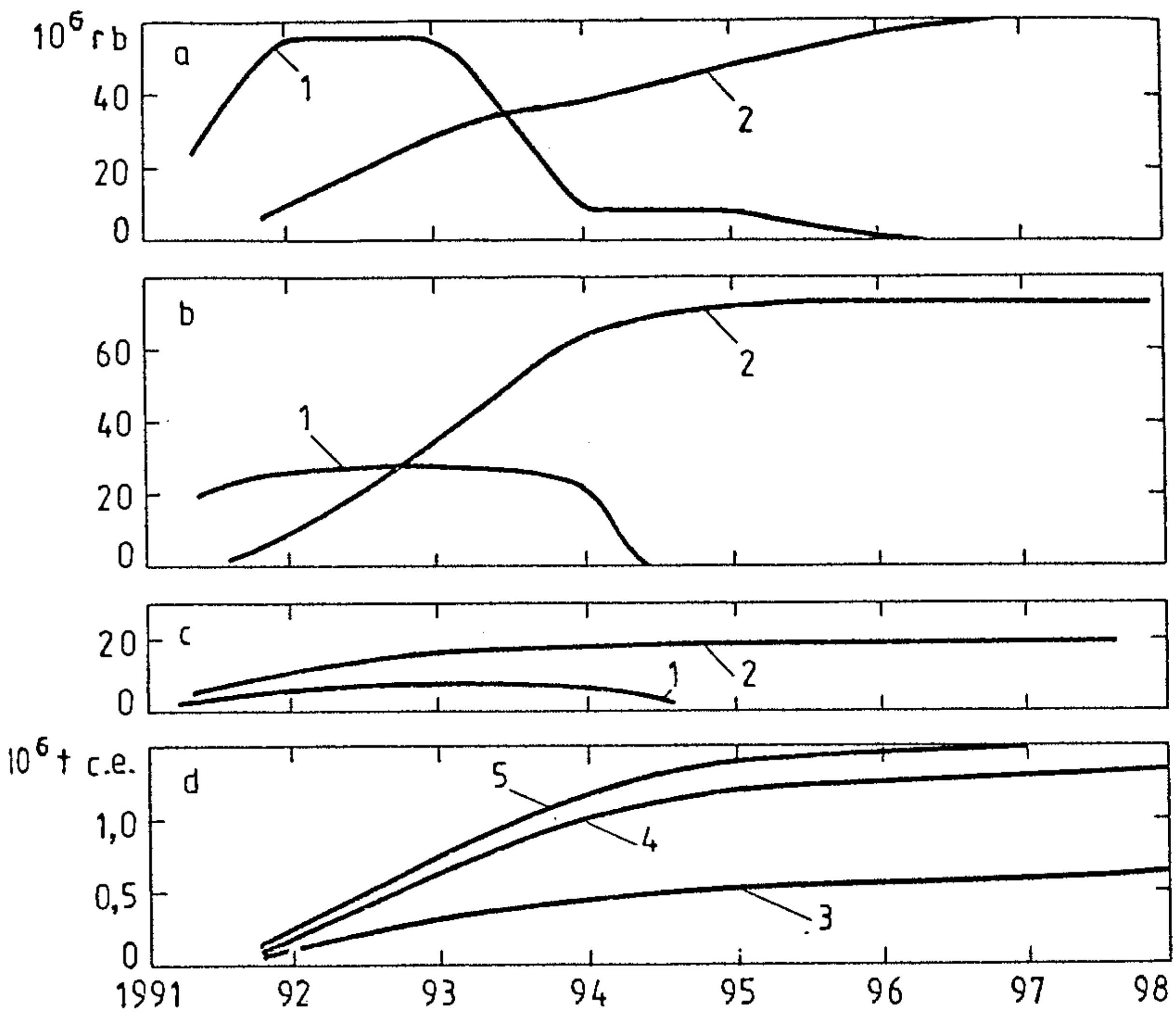


Figure 2.10. Dynamics of the capital investments (1) and revenue (2) with putting into practice means of heat metering and regulation devices in residential and service sector (a), in industry (b) and with implementating only electricity metering (c). There is presented below (d) dynamics of fuel saved with putting into practice heat metering and regulation devices only in residential and service sector (3) and also in industry (4), and also with only electricity metering (5).

Efficiency of metering and regulation equipment in residential and service sector is demonstrated in Figure 2.10. One could see, that the profit caused by fuel saving (achieved by implementation of the planned means) will exceed the capital investments already after 2½ years.*

Efficiency of capital investments for implementation of heat meters and regulation devices is three times higher in industry than in residential and service sector (Figure 2.10), the average pay-off period in industry is slightly more than one year.

It's necessary as fast as possible to introduce a new level of electricity metering, which will enable

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* In this report all the economic calculations were done in stable prices of 1989, with assumption that 1 tce of fuel costs 100 rb.

- to supply consumers with electricity meters especially in parts of industrial plants.
- to introduce different tariffs for electricity.
- to install control systems for separate devices and processes at enterprises utilizing existing communication lines of the 0.4-10 kV network.

An important energy conservation measure is to provide modern electricity metering and management equipment to the power network and modern computers to the dispatching stations, it will enable to reduce the energy losses in the network. It's very important in the interstate electricity trade with market prices.

The schedule for implementation of the electricity metering equipment and the corresponding financing is shown in Figure 2.10.c is real and necessary, if we want to be comparable with other civilized countries.

Let us review the main recommended means. The measurement instrument and the multitariff electricity meters are almost put into practice in the high voltage lines, to start their operation only an economic (or administrative) impulse is needed.

There is a need for roughly 500,000 multitariff electricity meters (in industry and in residential and service sector), but at present we could restrict ourselves with consumers who are able to smooth the load curve, i.e. to fulfil the function of consumers-regulators. Their effect is evaluated by the price of the maximal 120 MW capacity saved. Mastering with electric meters in part of industrial plants isn't their inner business at the moment, they must learn to think about it. It will hinder energy losses in the industry.

The Ministry of Economics and the Ministry of Trade & Resources should ensure production of the most necessary equipment for energy metering and regulation or buy it abroad. These ministries should urgently prepare a proper programme and take decisions in this area.

2.3.2 Energy Conservation in Existing and Newly Built Buildings

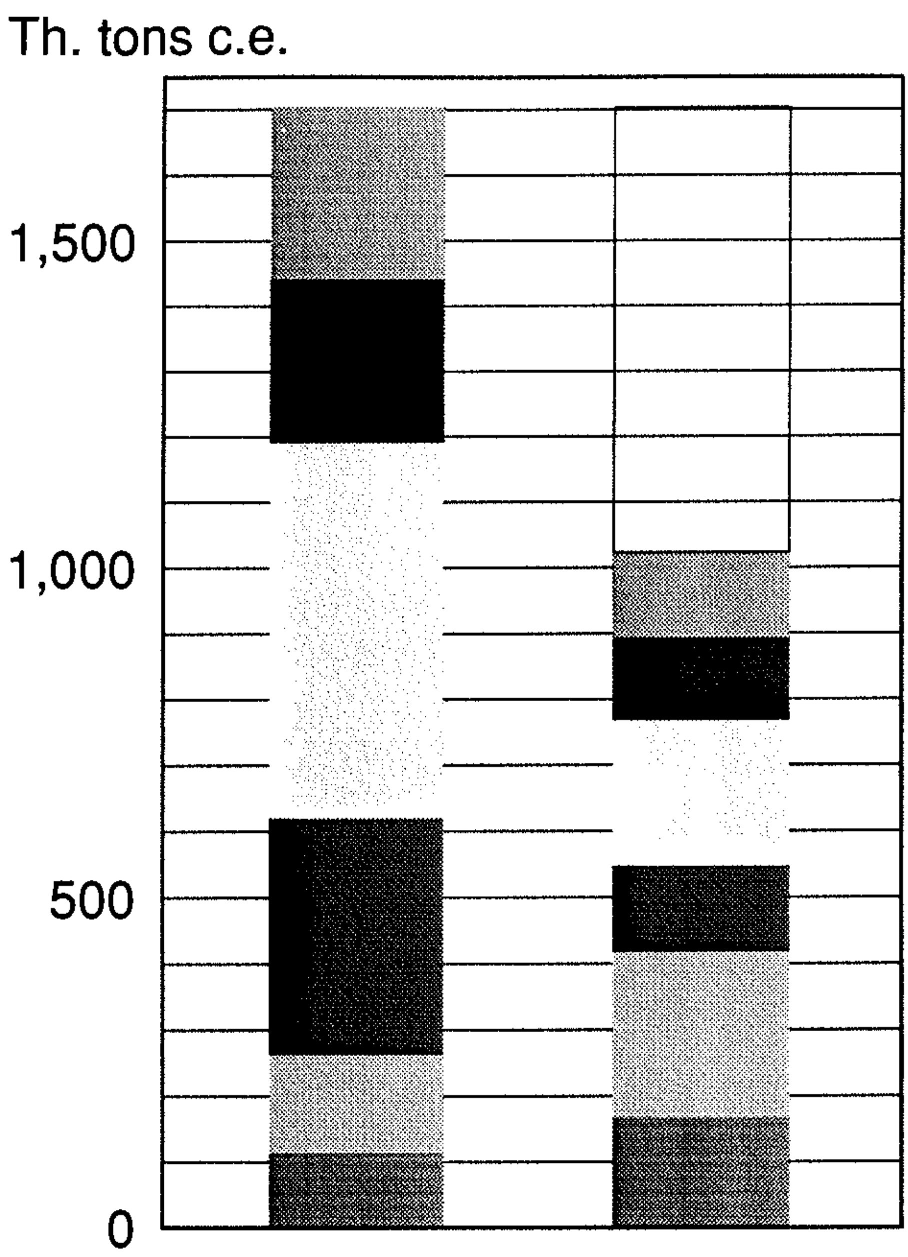
Calculations show, that about a half of net heat energy is consumed inefficiently due to imperfect constructions, engineering installations, improper maintenance and so on. Therefore the strongest efforts should be put on energy conservation.

Energy expenses in the building materials industry, in construction, as well as in heating of all types buildings are constantly increasing (in 1989 7.9 million tce of energy were consumed, accounting for 36% of the total energy expenses).

Energy losses in buildings due to their specific character couldn't be reduced rapidly with an implementation of some technical or technological means. It is tightly connected with an essential reorganization of the building materials industry, the construction industry and the other industries which should be managed by the government not only by economic but also by administrative measures.

The main task for the building materials industry and the construction industry is as soon as possible to change the existing structure of production towards reducing the energy expenses (Figure 2.11). Implementation of such a programme will save 40% of the total energy consumed in the discussed sector.

The proposed schedule for reconstruction of the building materials and construction industries is as follows:



	1989	Prospect for 1993
Glass and other	115	169
Insulation materials	150	250
Wall materials	357	130
Binding materials	571	220
Construction industry	250	125
Construction & erection, transp.	260	129
Energy savings		680

Figure 2.11. Present and perspective energy expenses in building materials, construction industries and construction works.

1. According to the national energy conservation programme a normative construction basis should be created in two years. It should determine the optimal energy consumption limits for the building materials, parts and constructions production, in the construction and erection work and in transportation, as also the energy consumption standards in the use of buildings. Economical and legislation mechanisms, a state expert commission for existing and new buildings and the state inspection which will assure the unconditional observation of construction standards should be created and put into practice.
2. In the next 2-3 years research and design projects, which will enable a technical and technological reconstruction of the construction and erection works, should be carried out. This will assure an optimal structure of building materials, parts and constructions production, energy savings in construction and erection works and in transportation, as well as an essential reduction of energy consumption in the exploitation of the buildings.
3. Management in construction and its technology should be reorganized in the next 3 years. It will enable us to reduce energy consumption in construction and erection work and in transportation up to 50% (in comparison with 1989).
4. The technology of the building materials industry should be restructured in the next 4 years, it will make it possible to produce building materials for new constructions and to increase insulation of existing building (thermal renovation) In 10-15 years the total energy demand could be reduced with 40% (in comparison to 1989). It should be emphasized that Lithuania will not be able to produce sufficient amount of insulation materials, and other renovation materials for all the existing buildings. It would be unprofitable. So the construction methods which need the smallest amount of building materials should be employed. Some building and raw materials ought to be imported. At the same time, reconstruction of the building materials industry will cause an overcapacity of some binding and wall materials, building constructions which could be exported and instead of them importing raw materials needed.

Results of the programme:

- The production ratio between support and insulation materials in wall constructions will be radically changed, the share of insulation materials will be raised from 9.3% to 19.9% and the total structure of building materials production will be changed. The main tasks are to reduce the cement production from 650 kg/capita to 350 kg/capita, to reduce 1 m^2 construction weight from 400-900 kg to 150-350 kg, to stabilize or reduce production of high energy consuming materials (bricks, claydite, reinforced-concrete constructions etc.) (Table 2.2).

A new fibre glass plant with a capacity of 600,000 m^3/year should be built (capital cost - 5 million 1989 Rb, design proposals exists).

Contracts with foreign companies to produce polyurethane, foam polystyrene, polyethylene, polypropenol, plastic and mineral fibre materials are needed.

The amount of insulation materials needed according to the programme are shown in Table 2.2.

Table 2.2. Predicted programme needs for the wall and insulation materials production with increased thermal resistivity in 2 stages.

Name of materials	Amounts of insulation materials in 1000 m^3		
	Present consumption	With $R = 2\ \frac{m^2\,deg}{W}$	With $R = 3\ \frac{m^2\,deg}{W}$
1. Building bricks (in 1000 items)	1000	800	500
2. Lightweight aggregate concrete	388	-	-
3. Claydite	73	81	-
4. Cellular concrete and gas silicate	158	161	68
5. Mineral wool	274	805	1439
6. Foam polystyrene	114	147	225
7. Perlite	24	38	48

In this way the material and technical basis for energy conservation in buildings would be assured.

As part of the programme a thermal renovation of existing buildings is planned, it will enable to save not only fuel but also reduce the district heat supply capacity, making it necessary to revise plans for heat supply in urban areas to year 2000.

The task to put into order insulation in 80% of the buildings in 10-15 years will give a net fuel savings about 2.5-2.6 million tce/year.

The realization of this task needs:

1. Preparing in two years and fulfilling until 2005 the thermal renovation of existing buildings (design, research, ordering materials, parts and constructions needed, technology and basis, legislation and standards).
2. Assemblage construction of the high energy consuming multi-storey buildings in bad condition should be reorganized and its industrial basis reconstructed (about 180.000 m^2 of the total area) in 4 years.
3. Production of energy efficient, humidity and air proof windows.
4. Technologies for an additional outer walls insulation, a program of their implementation, nomenclature of materials and parts needed prepared.

It should be stressed here that the structure of expenditures, fuel and capacity saved are different for roofs, walls, floors and so on. Taking into account expenditures needed to save 1 tce of fuel the capital investments alloted to increased wall insulation will be payed-off in 10-12 years without including a possible reduction of supply capacity (Figure 2.12.b).

If improvement of wall insulations in existing buildings will be postponed, the capital investments for thermal walls renovation in 1996 will be equal to the price of saved fuel (Figure 2.12 dotted line), but it will be not the essential solution of the problem.

In all the cases an improvement of windows construction should be speeded-up, because these measures are the most efficient and their introduction is unquestionable.

One of the main tasks is to improve energy conditions in new constructions in 2-4 years, this will reduce an increment of the annual energy demand

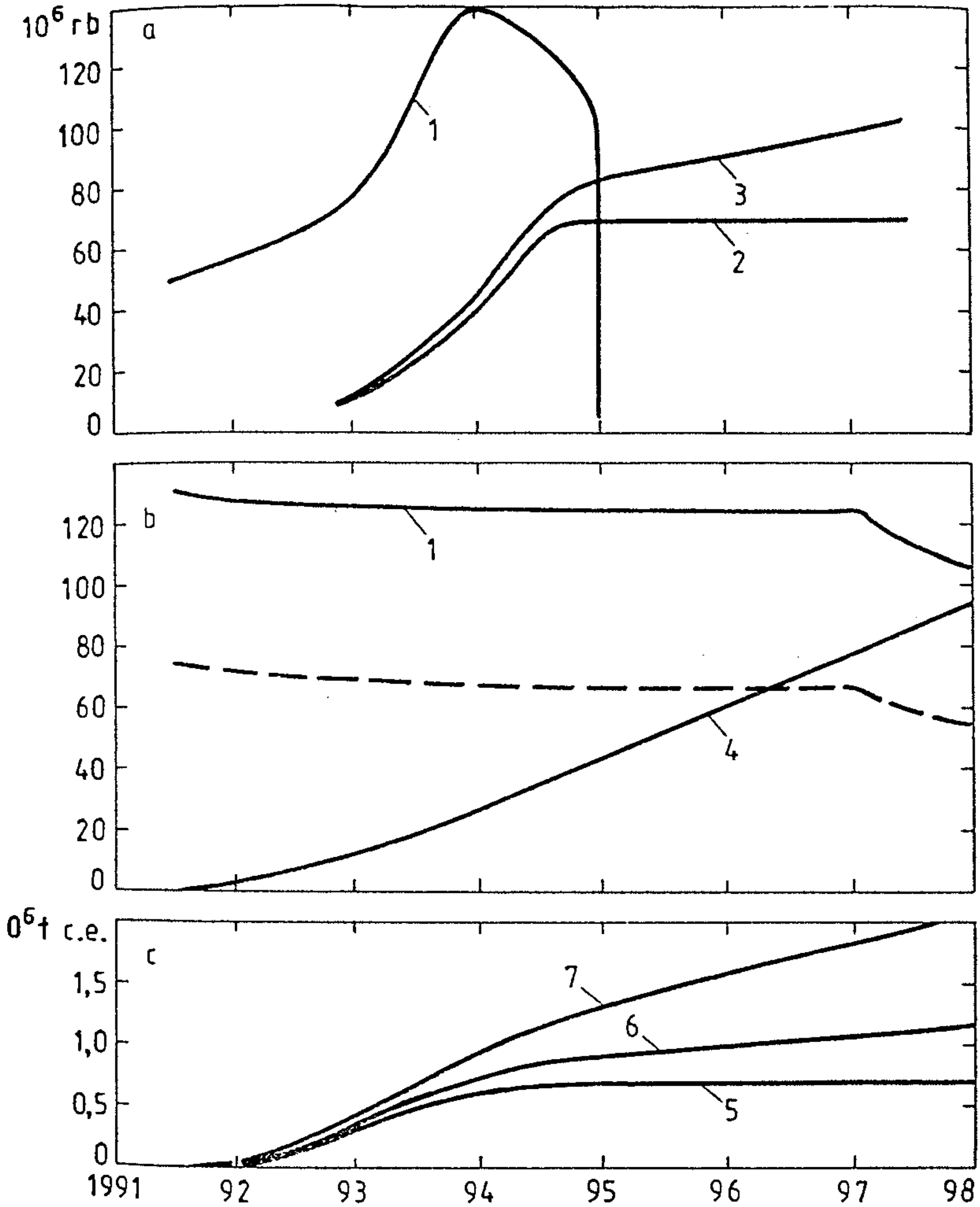


Figure 2.12. Dynamics of the capital investments (1) and revenue (2, 3, 4) after restructuring the building materials and construction industries (a), with insulation of existing building (b), and dynamics of fuel saved (c). Dynamics of revenue with and without taking into account expenditures for new construction (2-3). Dynamic of saved fuel without a new construction (5), with it (6) and also with thermal insulation of existing buildings (7). By dotted line is shown dynamics of capital investments without insulation.

by 120,000 tce/year. Energetic effect of these measures is shown in Figure 2.12.c.

Thus an urgent reorganization of the building materials industry, the construction industry and the construction works is one of the main strategic directions in the energy conservation policy.

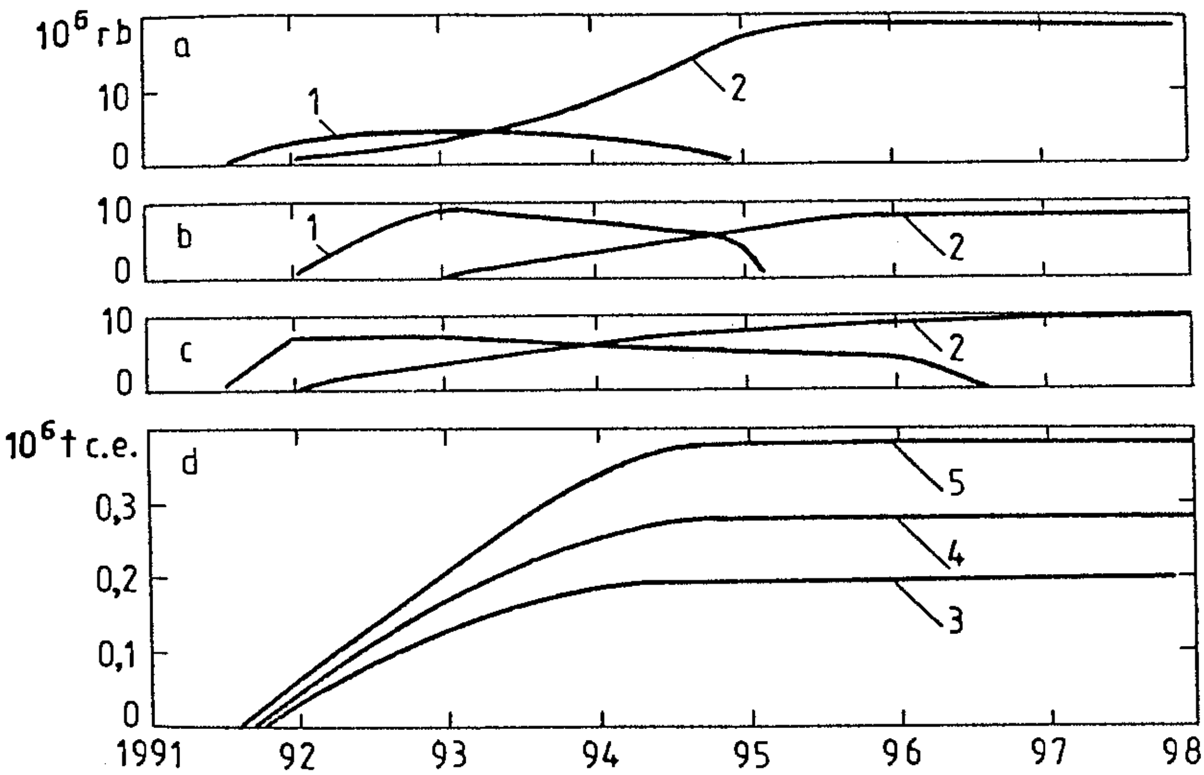
2.3.3 Increasing Efficiency of the Energy Consuming Equipment

Low efficiency of various equipment in energy consuming systems, such as heating, ventilation, electricity and gas supply, also causes a high energy consumption.

Increasing efficiency of the district heating systems by increasing insulation of the heat distribution pipes and other measures which enable to save not only heat but also metal. A reconstruction of district heat regulation substations should be done, computer controlled pumps should be implemented.

Various improvement of heat and ventilation equipment design in industrial buildings are efficient energy conservation measures. The majority of these measures need only small capital investments and may be put into practice by small special firms and companies. The total pay-off period of this equipment doesn't exceed one year (Figure 2.13). By introducing these measures in two years the total energy saved will be 83 th. tce/year and with utilization of the secondary heat - at least 190 th. tce/year.

Figure 2.13. Capital investments (1) and revenue (2) mastering with more perfect heating and ventilation equipment in industry (a) and in agriculture (b), as also utilizing the waste heat resources in agriculture (c). In the lower figure dynamics of fuel saved with implementation of above mentioned measures is drawn (d).



At present usage of heat pumps for heating of dwelling houses is very expensive. Lithuanian scientists could also help in searching for cheaper technologies.

Improvement of the energy consuming equipment in agriculture will cost more than in industry the average pay-back period of this equipment - 3 years (Figure 2.13.b). It is caused partially by specific agricultural technologies (the seasonal load of equipment prevailing) and a large energy consumption in heating and drying neglecting all saving measures. With putting into practice only the simplest energy conservation measure it is possible to save roughly 77 th. tce/year of fuel (Figure 2.13.d) in agriculture.

A lot of energy could be saved in industry as in agriculture utilizing waste heat resources (Figure 2.13.d). Mastering with them in agriculture requires about 180 million 1989 rb. of capital investments in 5 years, it will save about 670 th. tce of fuel.

Huge amounts of energy are wasted in industrial processes and saving possibilities by improving these processes are also huge. It was illustrated by the example from the building materials and construction industries. Roughly the same amount of energy could be saved by restructuring the chemical industry: reducing consumption of mineral fertilizers in agriculture and reducing their production. These potentials are however more difficult to exploit and mostly determined by interests of other branches or social interests.

Implementation of these measures may be speeded-up by economical stimulation. But until now the pricing policy was not in favour of these measures, it even blocked the way for introducing them.

In the transition to a market economy implementation of these measures may be rather problematic, if increases in fuel prices will be less than the increase in raw material prices.

2.4 Alternative Decisions to Increasing Capacities of Power Plants

2.4.1 Renewable and Non-Conventional Energy Resources

The invasion of cheap oil and natural gas didn't stimulate fuel conservation. It caused unjustified careless engineering and use of natural resources it produced waste which polluted our natural environment. Consumption of the indigenous fuels is constantly decreasing and in 1989 was only 3.2% of total or 0.7 million tce. At the same time the potentials in renewable energy resources are rather considerable (Table 2.3).

Economical evaluation of possibilities to cope with non-conventional and renewable energy resources is especially complicated due to contradictions among authorities in this area on the resource potential, technological possibilities and, particularly, investment needs in the period of rapid inflation. The following conclusions can be derived with sufficient reliability:

1. Coping with non-conventional and renewable energy resources is possible only with state subsidies.
2. Economical effect of the renewable energy resources introduction couldn't be instantaneous, it could be enriched with a social significance due to cleaner environment, and a psychological significance caused by participation in a social and technological progress.

Table 2.3. The economical indicators of potential renewable and non-conventional energy technologies.

Energy technology	Price of saved fuel rb/tce	Amount of fuel saved 1000 tce	Capital investments million rb	Period of introduction years
1. 20 kW wind turbine	1500	200	300	8
2. 200 kW wind turbine	6000*	200		8
3. 2 MW wind turbine	2000*	200	400*	4
4. Renovation of small hydro power plants	427.5	2.05	0.88	2
5. Construction of small hydro on existing ponds	1160	22	25.5	5
6. Geothermal energy	1000	200	200	4
7. Energy production using municipal waste	288*	500	144*	4
8. Solar collectors in fodder preparing	1215	0.037	45.2	4
9. Solar collectors in greenhouses for hot water preparing	2200	0.9	2	3
10. Biogas production from agricultural waste	6000*	500	300*	8
11. Synthetical fuel from energy crops	290*	240	69.6*	6

* - in USD

The potential of these resources is evaluated to be 1.5 million tce and may be introduced in 10-12 years. The means to cope with renewable and non-conventional energy resources are divided into two groups: 1) local technologies which are possible to implement in 5 years, 2) technologies that require hard currency investments (to buy licences, to establish joint ventures and so on). A rather non-optimistic view is presented in Figure 2.3. Nowadays the medium sized wind turbines (300-400 kW) require capital investments of a little below 1000 US$/kW. This means that electricity from wind power can be of the same cost as electricity from large coal fired power plants in a good wind regime.

Unrealistic low energy prices made the pay-back period rather long for wind turbines. Different from the Scandinavian countries like Denmark, in Lithuania the best future is for wind turbines operating at low wind velocity (less than 4 m/s). Research work in this area should be especially stimulated. Development of a Lithuanian wind turbines industry should be stimulated not only by economical measures, but also by legislative acts, which could give guaranties and priorities to wind energy producers. The Lithuanian industry and research potential could be able to fulfil the needs for smaller wind turbines. The larger wind turbines would have to be bought abroad.

Also urgent is a renovation and development of hydropower plants (HPP) with manufacturing of the majority of equipment needed in Lithuania.

Rather optimistic are prospects for geothermal energy introduction, though it's very hard to evaluate expenses needed to master with this source

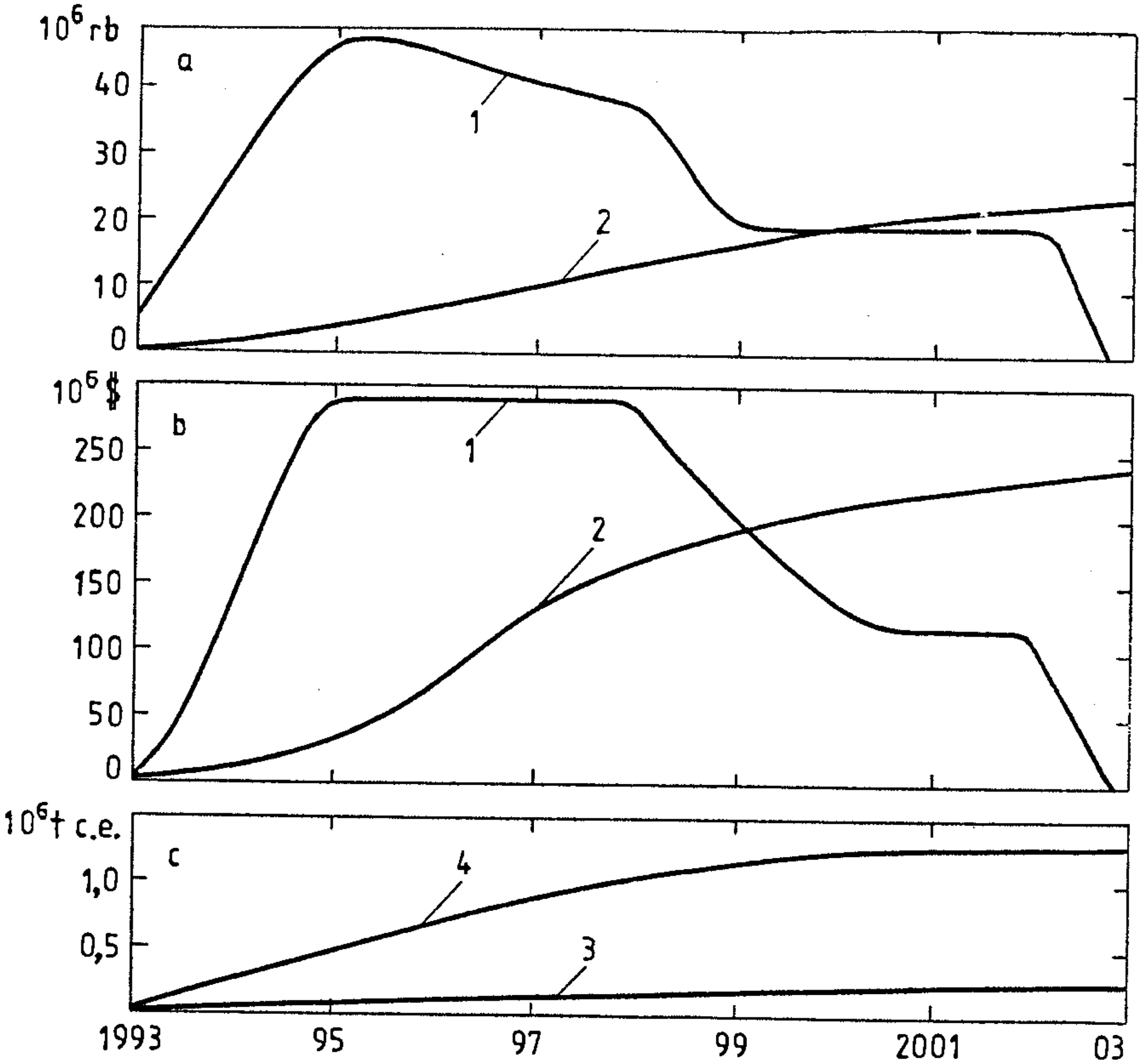


Figure 2.14. Dynamics of the capital investments (1) and profit (2) introducing renewable and non-conventional energy resources using local (a) and foreign (b) technologies, as also amounts of saved fuel (c): 3 - with implementation only local technologies. 4 - implementing local and foreign technologies.

of energy. Construction of the first geothermal heating central in Vidmantai (near Klaipeda) should be completed as soon as possible.

Solar energy is at present mostly used in agriculture, and its development is associated with large expenditures. The area of its application should be widened.

Among the renewable energy resources serious attention should be placed on burning of wood and municipal waste and energy crops. We think that it's possible to use energy crops to produce liquid fuel.

In summarizing we could say that with expected increase in energy prices, coping with the renewable energy resources should be backed by the state.

2.4.2 Allocation of Various Types Fuel and Energy

A serious problem in transition to a market economy is to change the allocation of various types of fuel and energy among various sectors of the national economy. The following problems should be solved first of all:

- the optimal distribution of fuel types between the individual and the district heat consumers.
- determination of an optimal ratio between district heating and individual heat supply systems.
- reduction of condense power generation and increase of combined heat and power plants.
- introduction of small decentral combined heat and power plants.

Reallocation of various forms of energy types will be going on by itself with an increasing technological level, rising level of life and so on.

Individual heating is predominant in single family houses in Lithuania, they are mostly burning solid fuel (coal, wood) in water heating boilers or stoves with an efficiency 40-50%. At the same time an efficiency from 60 to 75% is achievable when burning liquid or gaseous fuels. This problem should be solved by increasing the efficiency of individual heat generators, and also by supplying individual consumers with a better fuel quality. Solid fuel should be burned in power plants.

Now one can observe the opposite trend which caused almost total elimination of a solid fuel burning equipment in Lithuania in larger boilers. Storage of a liquid or gaseous fuel is rather complicated and Lithuania has no strategically urgent fuel reserves. In order to increase security of supply some boilers in power plants should be changed to burn 3 types of fuel (solid, liquid and gaseous) by implementation of modern technologies. Lithuania has some reserve of peat which could also be used to cover energy demands.

The monopoly in heat supply of urban inhabitants should be abolished. It requires:

- immediately to start a massive production of individual heat generators of up to 25000 units per year.
- according to the previously referred programme for reorganization of the building materials and construction industries, projects of new districts with individual heating should be urgently prepared and an experimental construction should start without delay.
- to switch municipal and industrial boiler-houses into CHP plants, as one of the main trends in increasing electricity production.

2.4.3 Alternative Decisions to the District Heating in Towns

The existing decisions in heat supply to town dwellers were prepared a long time ago, and were backed up by the traditional view of the obvious superiority of district heating. The total programme for a district heating development and thermopower plants enlargement was based on this premise.

The fuel expenses in the end-use heat consumption in Kaunas town were analyzed. The analyses showed that the main economical indicators of district heat supply are rather different in different districts. Differences in capital costs, cost of heat and normal prices are caused by a different thermal density (density of heat consumers) and distances from the thermopower

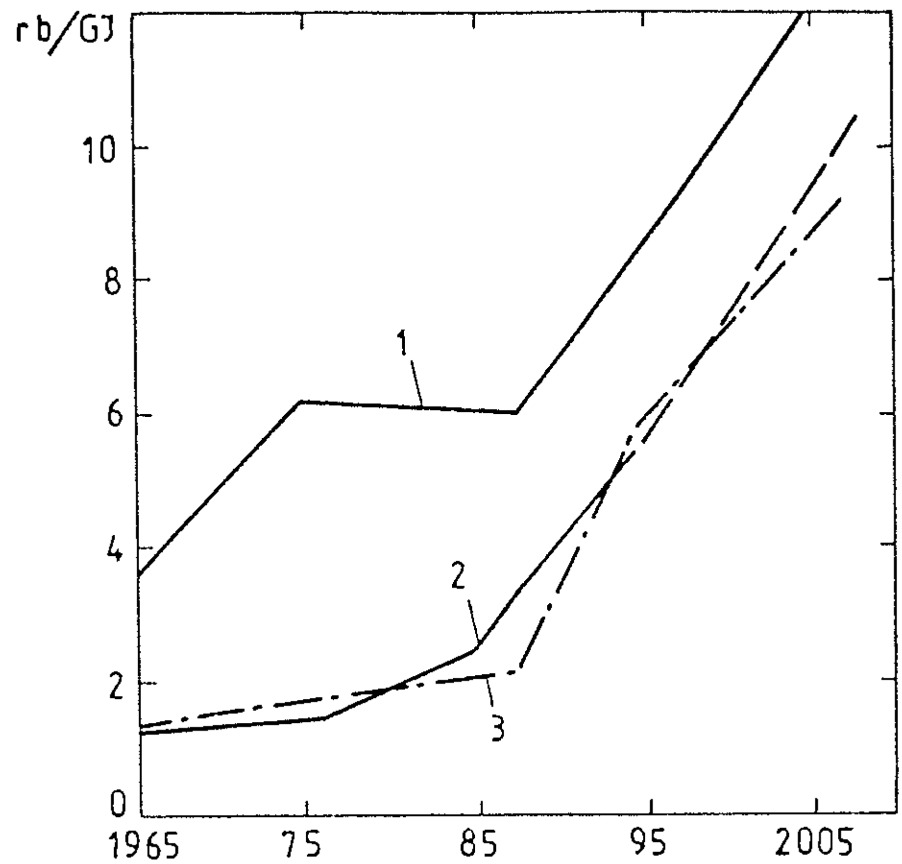


Figure 2.15. Dynamics of the economical indices of district heating in Lithuania (1 - unit capital cost, 2 - average tariff, 3 - full unit capital cost).

plants. The way the district heating system was constructed wasn't cost efficient.

This result could be extrapolated to other district heating systems in Lithuania. It means that 44% of the heat supplied from thermal plants are lost, therefore the real energy cost is considerably higher. The pay-back period for the development of district heating systems equals to 30 years. In fact it means fuel losses.

In Figure 2.15 are presented the dynamics of the district heat production capital intensity, its cost and its average unit costs in district heating systems up to the year 2005 if the planned district heating development would be put into practice. The results show that the previous way of development for district heating leads to a technical and economical deadlock.

The provided analyses gives a background for a plan of heat supply development in Lithuania. According to the programme for reorganization of the building materials and construction industries a large scale thermal renovation of the existing buildings (increasing their insulation) is planned and an alternative heat supply system is proposed. The main scenario shows possibility to save 4300 MW of heating capacity in 2005 (Figure 2.16).

The total capacity of boilers which are planned to close down is about 700 MW. We think that a reconstruction with a modernization of the units (some of them may be converted into small CHP plants) is a more progressive way. So about 4900 MW from the total 5800 MW capacity planned in 1990 to introduce could be saved by increasing insulation of buildings and modernization of boiler-houses. Therefore only about 1200-2400 MW of new capacity will be needed. Bearing in mind an economical and technological inertia the total need of new capacity is 2400 MW including 1200 MW until 1995.

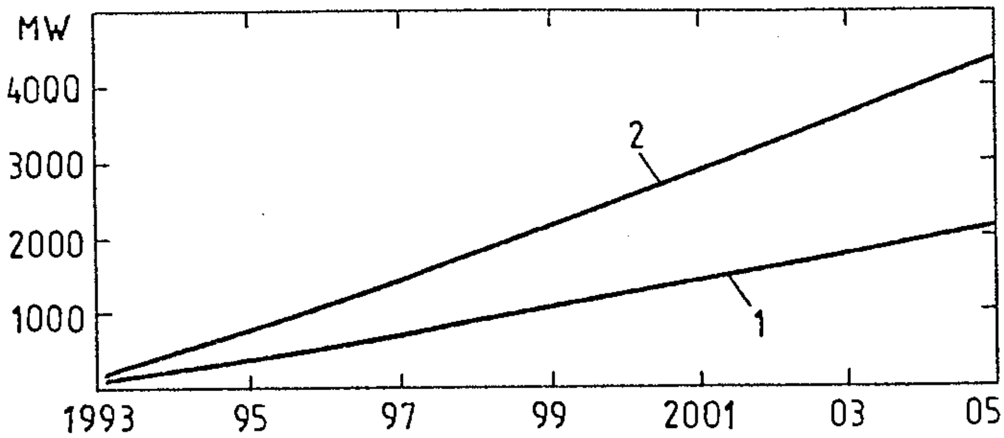


Figure 2.16. Dynamics of saved heating capacity in new buildings (1) and with thermal renovation of existing buildings (2).

Table 2.4.

Structure of capacities kW	800	200-300	20
Demands, units	100	2000	12000
Capital investments, million rb	100	500	12

However the present crises has changed the picture from 1990, now there is no need for this new capacity.

A detailed analyses of the consumer structure enables to evaluate the demand for individual heat generators and their structure to meet an increase in heat demand of 1000 MW (Table 2.4).

One should pay attention that implementation of heat metering and regulation equipment with an increased insulation of building (thermal renovation) will halve the heat demand. It means that the specific constant operation expenses (expenses to produce a unit of heat) in district heating systems will increase almost twice.

It's obvious that the capacities of the district heating systems should be reduced, with reducing the value of their fixed capital cost and introducing individual heating systems in residential areas with a low density of heat consumers, with old and worn out pipes and high cost of heat.

Obviously, this schedule of reorganization should be corrected according to the financial capacities of the state as also the implementation of the other energy conservation measures.

2.5 Government Strategic Tasks in Energy Conservation

2.5.1 Strategic Directions in Reconstruction of the Energy Systems

Realization of the concrete technical and economical energy conservation measures requires to solve a complex of serious problems at the governmental level, it's impossible to introduce these measures at once by an administrative order. A step-by-step process could be successful if coordinated and managed well.

The essential precondition in managing the introduction of energy conservation measures as a step-by-step process is an inevitable rise of the fuel prices to the international level. But the uncontrollable price hike couldn't help itself Lithuania to overcome the deadlock. As foreign experience shows, the conventional pricing system based on the usual demand and supply principle in the energy system even under market relations couldn't alone guarantee the efficient investment policy with an efficient allocation of capital investments in energy production and consumption sectors.

The following directions in reconstruction of the energy system should therefore be supervised by the state:

1. An urgent provision of energy consumers with the means of metering and regulation devices.
2. A reorganization of the building materials industry and the construction industry.
3. Production of the modern heat generators for individual heat consumers.
4. The systematic introduction and stimulation of the renewable energy resources.
5. Stimulation of coal import which enables also to make necessary reserves.
6. Mastering the new less energy consuming technologies.

The energy conservation measures could be introduced by applying economic and administrative instruments and coordinated by the State Energy Conservation Commission created in the spring 1992. The main functions of this commission could be as follows:

a) formation of the investments fund for implementation of the energy conservation measures. The state energy conservation commission should be authorized to use rather large investments in order to start the initial stage of technical reconstruction.
b) creation of the integral database of energy conservation measures, it will enable efficient financing and will stimulate main research projects, designs, creation of the pilot projects.
c) to help enterprises, firms, companies to do research, designs and production in this area.
d) to reform the capital investments policy by evaluating an efficiency to these investments as an efficiency of the integral energy system and not as a conditional efficiency of the isolated units. Methodologies for calculation of the capital investments efficiency and of economic efficiency should be changed and the old harmful methodology of the comparative capital investments efficiency discarded.
e) to create the background and introduction a pricing and taxing system which will stimulate an efficient energy consumption according to the following principles:
   - electricity and heat tariffs should differ according to the different consumer groups, reliability of supply, time of consumption, foreseeing the different tariffs in summer and winter, on weekdays and on weekends, at day and at night, minimal and maximal loads and advantages for an efficient energy consumers.
   - new energy tariffs should be announced beforehand, so that consumers could foresee, buy and implement the economically possible energy conservation measures, and suppliers could offer the necessary equipments.

- the new preferential tariffs are only for consumers possessing the suitable energy meters.
- to the consumers without the suitable meters the new energy tariffs are introduced not later than one year after adoption of these tariffs or from the moment when the reliable meters were available to the consumer.
- installment of the meters will be done by energy suppliers. The equipment could be sold to and installed by the residents, giving cultural and educational institutions credit without interest. The non-interest bearing credit could be given also to the manufactures of the metering and regulation equipment.
- laws with guaranties of the economical interest to consumers and producers should be prepared. Without introducing these measures in time implementation of the energy conservation measure is impossible.

f) to revise the heat supply projects, because alternative systems could be individual or mixed energy supply systems. To stimulate a massive implementation of the efficient individual heat generators, transmission and regulation equipment.

g) one of the main governments tasks in this period will be to check the costs calculations when prices of fuel and energy are rising, and to ensure the fulfilment of the energy conservation policy.

2.5.2 Principles of Restructuring the Lithuanian Energy System and the Pricing Policy

The main measure to increase efficiency of the Lithuanian economy is to introduce market relations. Mastering these relations in the energy system is a rather complicated problem. The present system of economic relations in the energy system is backed by a strong and centralized regulation, it couldn't stimulate increase of energy generation efficiency, but could become a hindrance to implementation of market relations in all sectors of national economy. So in the energy system economic relations should be compatible with market relations. Experience of Western countries confirm this. For example, in Finland the state doesn't interfere into energy pricing, energy prices are settled by competition at the market. Competition is also developed in the Swedish energy systems. Such relations were established after a long period of experience. We have no time for experiments, such relations should be introduced artificially by decentralization and demonopolization of energy production and distribution. So some transitional period is inevitable and during this period the integral energy system should be divided into more or less autonomous units, separating supply and distribution. This is very important at present, when the problem of additional energy generating capacities is under decision. If the decision is in favour of large power plant construction, it will complicate mastering with new economic relations.

Implementation of additional energy generating capacities by switching the existing boiler houses into combined heat and power plants would create a lot of small energy producers and introduce competition into the energy system. These units should be self-supporting economically and have an individual managing task. Trading relations between these units should be organized and until competition is sufficient it is better to install a united pricing system. Introduction of the pricing system demands a mechanism for expenditures declaration.

The pricing system should be prepared under the assumption that a price is a measure of optimization and not a centrally fixed pricing system. We propose the following main features of the pricing system:

1. In the interstate trade the energy price is determined by the marginal energy production and transmission expenditures in the energy exporting state. These expenditures depend on energy consumption conditions and vary in time. Thus a different tariff system is necessary.
2. Energy conservation measures are introduced on a voluntary basis and their effect should be competitive. It means that the most expensive producer is abandoned.
3. The impact on the environment is evaluated by an additional tax, which is established according to the possible economic losses in the national economy if the energy production was reduced to permittable limits with respect to environment. In a transitional period the capital from the additional tax is accumulated by the state and will be used to widen the mentioned limits.

In the power system these principles could be introduced by abandoning common energy price in different enterprises. The Lithuanian power system should buy energy from power plants and sell it to distributors in prices formed according to expenditures declared.

Fears of a negative reaction to varying and different tariffs are totally groundless. Consulting representatives of consumers energy engineers from the large industrial plants are in favour of market relations in the energy system.

2.5.3 Intersectorial Problems of Energy Conservation

The large potential for energy saving is in the area of intersectorial relations in the Lithuanian economy, though their restructurization isn't in the sphere of interest of the national energy efficiency programme. In this programme it is stressed that an essential reorganization of the building materials and construction industries is urgent, without it one couldn't even hope to master with the energy conservation measures. The essential reorganization of other sectors of national economy would also considerably increase the amounts of saved energy.

In transport the large benefit of energy conservation could be a creation of an integral transport system compatible with systems in other countries. The system includes road, rail, water and pipeline transport, often even without taking into account Lithuanian interests. The state of all transport systems should be analyzed and a new programme for their development prepared. Especially urgent are the following problems: development and electrification of railways (at present almost only Vilnius-Kaunas is electrified) river-transport, more deep exploitation of Klaipeda-Mukran (Rügen) ferryboat, transportation of motor fuel by pipelines, and creation of a modern service system. These measures are rather energy efficient but expensive, their introduction would depend on the interest of other sectors of national economy.

In **agriculture** the main direction in development should be the structural changes in agricultural branches, a quicker development of less energy and materials consuming branches. Technologies which reduce consumption of raw materials, give no waste, or utilize waste and byproducts, utilize renewable energy resources should be stimulated.

In **wood management** the main aim would be stimulating to utilize timber waste as an energy resource. Especially important is an urgent analysis of energy crops perspective, to get the soil needed and to create institutions needed for its realization. Implementation of these measures in the most polluted areas would help to restore environment and to meet the minimal demand of indigenous fuels.

In **industry** goods which consume less energy should be preferred in comparison with other products. Production of equipment for energy metering and regulation, production of small energy machinery and energy saving means, as well as mastering with new less energy consuming technologies should be stimulated in every possible way. On the other hand, by the economic measures high energy consuming goods and industrial products should be hindered.

The Ministry of Energy and a state energy conservation commission established by the government should coordinate the national energy efficiency programme as well as manage its adjustments.

The Ministry of Energy should provide information, training and education in energy conservation, employing television, films, advertisements, exhibitions, reviews, exhibitions. One of the main tasks - publication of material prepared during this research.

In this programme the government should use not only technical and economic regulation of production conditions, but also create means for preferential credits in energy conservation. Economical mechanism for efficient energy consumption and savings will operate only when all the main state regulation measures is introduced: taxes, subsidies, state investments, preferential taxes and credits, economic sanctions and regulation of economic activities by the corresponding legislation. All these measures are needed to make the energy savings programme effective and will give a significant benefit to the Lithuanian economy.

3 Energy Scenarios for Latvia

The main methodological difficulties of setting directions for the development of the energy system in Latvia are connected with the transition to market economy and the deficiency of local energy resources and electric power. Besides, the directions and rates of economic development of the republic remain still indefinite. Under these circumstances the chief task is making a strategy for the development of basic branches of the energy system considering the variety of economic development rates in the country and the growth of energy consumption. Particularly it refers to the gas supply system and improvements of the electric power system that require significant investments. In order to solve the problems of the electric power system, the main difficulties arise from the present situation in which the local generating capacities provide only 50% of the electric power consumed and plans should be made for Latvia to be provided with its own electric power.

The basis for scenarios for the directions in which the energy system of Latvia could develop are perspective forecasts of the energy consumption. Under market economy the structure of the energy consumption patterns may change fundamentally depending on price changes of on primary energy resources and on the market relations.

Registration of energy-ecological factors, alongside with the energy-economical ones, is a new strategy for the development of scenarios for the Latvian energy system.

3.1 The Economic Development Rates of the Latvian Society

Forecasts for the basis indices (one of the variants from the beginning of 1990) for the development of national economy are presented in Table 3.1. However, one should take into consideration that these data are to be corrected according to how the national income will change under the circumstances of market economy, existence of different forms of property, a new concept of the development of national economy, the Government Programme aimed at stabilizing national economy in the nearest future and structural changes to be expected in industry. The purpose of the Government Programme is to stimulate the production of goods for the population in Latvia particularly and for the world marked.

Industry will be oriented towards the branches of production that have a complete cycle of the type: »Resources-production-final product«, relatively small energy and material capacity and that may ensure at the same time the influx into Latvia of freely convertible currency.

Antimonopoly measures will be taken, a net of small enterprises developed in order to provide healthy competition.

All the measures will be carried out gradually and reasonably, preserving vacancies, giving the workers a possibility to train for a new profession without harming the society and interrupting the existing horizontal links among the enterprises.

In the nearest future the following actions are envisaged: setting up of a new cellulose-paper combined enterprise, start of the production of cement, reconstructing the »Sarkanais metalurgs« metallurgic plant so it will be capable of meeting the requirements of the Baltic countries, expanding the Jelgava »RAF« plant of microbusses, developing the capacities of Riga Carriage Factory and changing the character of many machine-building and metalworking enterprises. Much hope is laid on the quality of furniture, primary processing of wood and products of light industry, turning to local raw materials (flax, wool, leather and scrap).

Freight turnover increase through the sea ports (Riga, Ventspils and Liepaja), a possibility of building an oil-stabilizing plant before exporting and an oil-refinery for the requirements of Latvia or increasing the capacity of the existing ones in neighbouring countries are the problems which have to be solved quickly.

Serious changes will take place in the approach to the housing-problem, as a result, it is expected to cut down the building of new multi-storeyed houses in major cities and regional centres.

All this shows that particular attention should be paid to the forecasts of development which is the bases for any projection of the energy requirement. This work presents only a preliminary draft which will have to be revised soon on the background of events in the Baltic as a whole.

3.2 Analysis of the Present Energy System

The Latvian energy system includes the following objects:

- 2 large cogeneration power plants including Riga TEC-1 and Riga TEC-2 with total capacity of 530 MW;
- 3 hydro power plants of the Daugava cascade with the capacity of 1487 MW;

Table 3.1. Indices of economic and social development.

	1985	1990	1995	2000	2005	2010
Gross national product, billion roubles	16.4	20.6	21.2	25.6	31.1	38.0
National income (derived), billion roubles	6.4	8.7	9.2	11.8	14.7	18.3
Population, in thousands	2585	2686	2725	2766	2806	2848
including: urban population, thousands	1821	1913	1943	1981	2019	2058
rural population, thousands	764	773	782	785	787	790
Number of workers imployed in material production, in thousands	1028	1018	958	935	887	804
Number of workers employed in non-material sphere, in thousands	367	391	440	480	540	600
Provision of the population with general dwelling space, m²/person	18.7	19.4	20.6	22.0	24.2	26.0
urban	17.0	17.7	18.8	20.4	22.0	23.8
rural	22.8	23.7	25.1	26.2	27.2	34.4
Capital investments of total work (in 5-year periods), billion roubles	8.3	9.7	11.8	14.8	16-18*	18-19**
Material capacity of national product, roubles/roubles	0.577	0.586	0.569	0.552	0.534	0.520
Energy capacity of national income, kg ce/roubles	2.095	1.608	1.342	1.113	0.925	0.770
Electric power conssumption, TWh	9.5	10.2	12.0	13.4	15.0	16.8
Electric capacity of national income, kWh/roubles	1.5	1.2	1.3	1.1	1.0	0.9
kg ce/roubles	0.345	0.356	0.335	0.298	0.267	0.240
Electric equipment, thousand kWh/worker	6.9	8.2	8.6	9.6	10.9	12.3
Fuel capacity of national income, kg ce/roubles	1.887	1.407	1.158	0.950	0.782	0.648
Consumption of furnace fuel, total, million tce	8.0	8.5	9.3	10.0	10.9	11.5
including: natural gas, million tce	2.5	3.4	5.0	6.2	7.2	8.0
mazut, million tce	2.3	2.0	1.9	1.6	1.4	1.4
coal, million tce	0.9	0.7	0.9	1.0	1.2	1.2
Other kinds of fuel, million tce	2.3	2.4	1.5	1.2	1.1	1.0

* Including »the big energy source«.

** Including also electric power from stations with specific consumption 325 gce/kWh working in neighbouring energetic systems.

- several block stations with total capacity of 26 MW;
- about 8900 boiler-houses producing 21.2 million Gcal a year, 10% of them with a capacity of 50 Gcal/h and more;
- 0.4-330 kW voltage electric power transmission lines with transformer substations, with a total length of more than 100 thousand km;
- Incukalns underground gas reservoir with the capacity of 2.1 billion m^3;
- Riga export facility for liquified gas with a reservoir pool of 8000 m^3;
- 4 distribution stations for liquified gas with the reservoir pool of 875 tons;
- 19 mobile stations for liquified gas for automobiles;
- 3 compressor gas-filling stations of liquified gas in Riga and Liepaja;
- 40 gas distribution stations and 1236 km of main and distribution pipes for natural gas;
- Ventspils crude oil and oil products export facilities with capacities of 853 thousand tons for oil, 112 thousand tons for diesel fuel, 46 thousand tons for petrol, 16 thousand tons for mazut (with the total turnover of oil products up to 26.4 thousand tons a year);
- 16 oil depots with the total capacity of 352.8 thousand m^3;
- mazut depots of various enterprises with the capacity of 407.5 thousand m^3;
- main pipes of oil products to ventspils with the total length of 320 km;
- 141 automobile filling stations;
- solid fuel depots with the capacity for coal 230 thousand tons, for peat bricks 3 thousand tons and for wood 70 thousand m^3;

980 km of mains and heat distribution network with central (300 pieces) and individual heat knots.

The resources of hydropower in Latvia could theoretically provide an annual output of 4.15 TWh electricity, including the river Daugava within the limits of 3.6 TWh. The resources of the Daugava are exploited at the extent of 2.74 TWh or 66% of the total national hydro power resource.

Table 3.2. Country comparison (the specifile consumption is excl. losses and consumption at power plants)

	Area thousand m^2	Population million persons	Electric production TWh	Electric production % from Gross electric power consumption	Net Electric power consumpt. TWh	Spec. net electric power consumpt. kWh/person
(Data from 1989)						
Latvia	64	2.67	5.8	56.6	8.7	3243
Estonia	45.2	1.56	17.5	173.7	6.9	4430
Lithuania	65.2	3.68	29.1	171.3	13.3	3614
(Data from 1988)						
Denmark	43.1	5.12	28.0	86.9	28.1	5488
Finland	338.1	4.93	58.6	87.5	55.6	11158
Sweden	450.0	8.41	146.5	99.8	118.8	14138
Netherlands	36.9	14.6	69.6	85.5	81.4	4757
FRG	243.1	61.3	417.5	96.8	431.6	7031
GDR	108.3	16.7	118.3	98.6	120.0	7100
Poland	312.7	37.8	144.3	97.0	148.8	3812

Such resources as peat and wood used as fuel for generating electric power have not lost their importance.

The consumption of electric power in the national economy and by the population of Latvia were 10.25 TWh in 1989 from which 39% were consumed in industry, 27.5% in municipal services, 16.2% in agriculture, 4.1% in transport, 0.6% in building.

During the period of 1983-1988 the mean annual growth of electric power consumption was 2.9% (in the Mutual Economic Assistance States, except the USSR - about 3%, in the states of European Economic Association - 3.3%, average in the world - 3.9%.

The place of Latvia among the neighbouring states of the Baltic region is shown in Table 3.2.

3.3 Electric Power Consumption Forecasts

Substantial economical changes open a new direction in the development of energetics. The state of the energy system will be central in this transformation of the society. Under the new circumstances a prominent place goes to those electric technologies which ensure immediate improvement of labour and living conditions of the people, electrification of an agricultural production, food storage and processing. Industrial electric technologies aimed at raising the quality of the products and their competitive ability in the world market are gaining importance, as well. There will be high demands for ecological purity and safety of energetic objects. The price of social and economic losses due to interruptions of energy supply is rising and as a consequence, the requirements are becoming more and more severe in relation to the vitality of the energy system and the reliability of energy supply.

The development of the electricity system is inhibited by deformations in the development of electric energetics, such deformations being moral and physical wear of the power equipment (Kegums hydro, Riga TEC-1 and block heat stations of the system), irrational structure of energy capacities, constant deficiency of reserve capacities which should providing the manoeuvrability and reliability of Latvian power system.

All this requires the development of a new concept of electric energetics in Latvia in cooperation with the other Baltic countries. This development will thus take a significant amount of time.

Since the conditions of the development of electric energetics on the new stage cannot yet be assessed in terms of numbers, it seems necessary to develop this concept as a number of different variant - in order to recommend reliable strategic solutions.

The concept of economical development should make the basis of the programme for the development of electric energetics of the republic.

There is a programme of the Latvian government which allows to draw the following conclusions:

1. Preference should be given to agriculture, that is, it will gain by rational consumption of electric power without limitations on the part of the Latvian power system.
2. The power demand of the individual branches of industry will develop in accordance with their share of their production in the growth of national income and competitive abilities in the world market.
3. Raising the living standards of the population in Latvia should be ensured.

These principles were adopted as the basis for a forecasting analysis of the electric power consumption for the next 15 years.

Electric power consumption in Latvian Republic for the year 2005 was assessed by different groups:

- by specialists of IPE of Latvian Academy of Sciences - 17.1 TWh (mean annual increase of 3.3%);
- by branch specialists - 16.6 TWh (mean annual increase of 3.1%);
- by using a statistical method of analysis and forecasting - 15.4 TWh (mean annual increase of 2.6%).

The process of transformation in national economy of the republic is accompanied by low increase of electric power consumption (in 1989 even a decrease in comparison with 1988).

Due to the change in the profile of the Latvian industry to be expected in the next five-year period of 1991-1995, with a priority to the development of industries with lower power intensity, agriculture, dwelling and municipal sector, general restrictions of new building, a low increase of electric power consumption will apparently take place. A deficiency of power resources, particularly in the period untill 2000, will also have its effect on the electric power consumption rates, hindering the material growth of the national economy. Yet, in the future, the situation may radically change.

One of the most important directions in the development of the economic complex is rational and economic consumption of energy. At present, irrational and wastefull consumption of electric power with high losses are connected with bad labour organization, low level of operation, violation of technological disciplins, output of low-quality products.

According to the data of the Energy Inspection of the Latvenergo enterprise, today the direct losses of electric power in e.g. the industry in Latvia is about 400 GWh a year, (more than 10% of the consumption). These losses, can be eliminated without any significant expenses. Beside these direct losses are the losses connected with the need to change the technology of production, the equipment and to introduce the achievements of scientific and technical progress. In order to remove these losses, it is necessary, in most cases, to have foreign currency, technologies and equipment. The factor of conjuncture may also play some part for the consumer of electric power. Therefore, this part of losses will not possibly be eliminated in the foreseeable perspective.

Considering this, one should expect the consumption of electric power in Latvia by the end of the period mentioned to be approximately 15 TWh (2.5% the average annual increase in the period from 1990 till 2005), this consumption is used in Table 3.4.

The balance of electric power for different variants is showing in Figure 3.1.

There is a great need for further work in the field of energy demand projections. In this report we will build on the three above mentioned estimates for the growth of electrical power consumption in Latvia during the period up to 2005.

In this connection one should take into account the agreement reached by the energetic ministers of the Baltic republics (protocol from May 31-June 1, 1990) on mutual exchange of electric power between Estonia, Latvia and Lithuania.

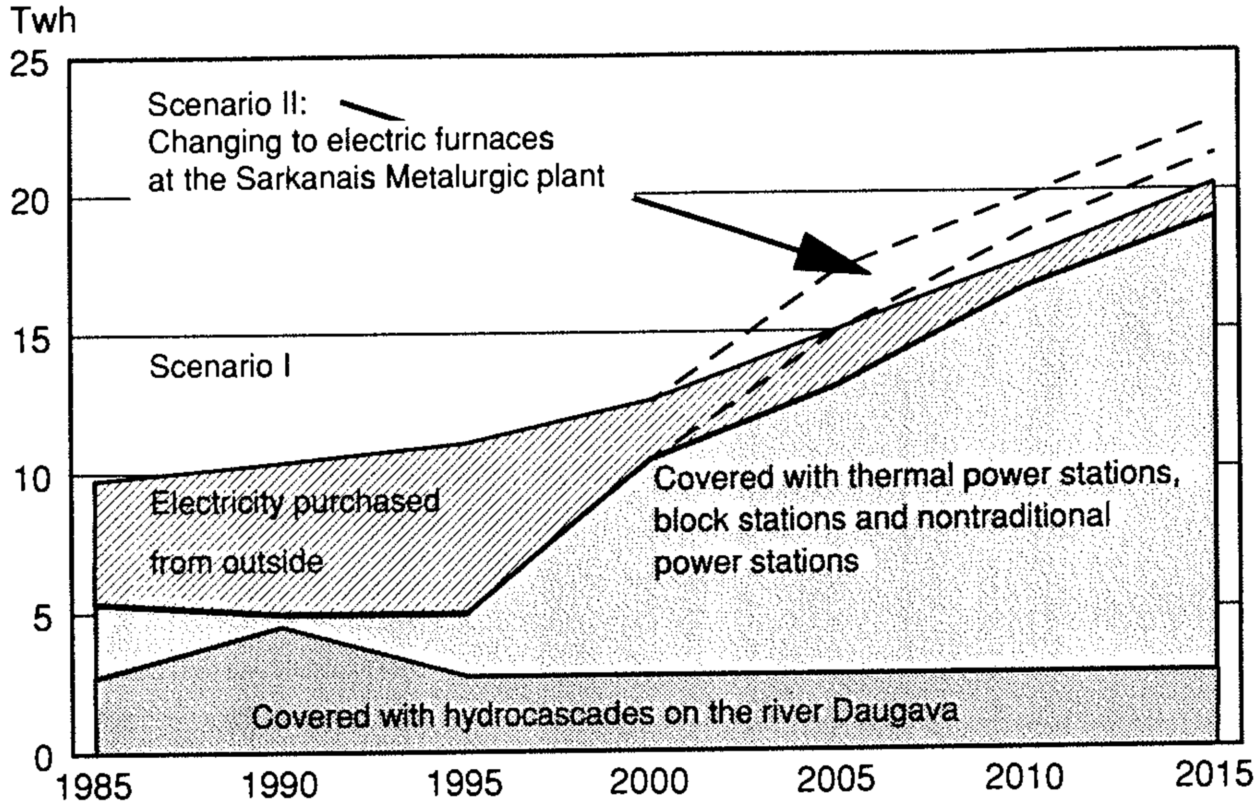


Figure 3.1. Balance of electric power in Latvia.

3.4 Increase of Existing Power Plants

The necessity to introduce new generating sources of electric power and the existing technical possibilities (the potential of boilers, the availability of gas and the need to raise efficiency) to install the new equipment, enables to plan the increase of power capacity in the existing power plants in Latvia stations with the following amounts:

3.5 Use of New and Renewable Sources of Energy

There is growing interest presently in the new and renewable sources of energy (NRSE).

In Latvian conditions in comparison with other NRSE, wind and biomass equipment may find vast application. Their functioning is determined by the necessity to solve, first of all, ecological problems. Their contribution in the energy balance of the republic on the level of the year 2005 may be calculated as 0.4% - 2% (the minimum-maximum variant) of the total electric power output.

The present programme envisages the restoration of 7 small HPS (Hydro Power Station) with total capacity approximately 4 MW (out of 21 former small HPS with the total capacity 7.4 MW).

Some of the other smaller capacity stations could be restored by the owners of the given water reservoir complex.

Table 3.3. Potential for increase of existing power plants. (TEC = Fossil fuelled combined heat and power plant, HPS = Hydro power station)

Name of the station	Electric capacity installed, MW			Method of capacity increase
	Existing	increase	final	
Plavinas HPS	825	75	900	Technical transformation without increasing the output of electric power
Kegums HPS	260	12	272	- " -
Riga TEC-2	390	500	890	Expansion with installment of new equipment
TEC of Jelgava sugar plant	6	6	12	- " -
TEC of Liepaja sugar plant	0.6	8	9	Reconstruction with the change of the basic equipment
TEC of Rezekne canned milk combined plant	-	6	6	Installment of a turbo-aggregate in the existing boiler-house
TEC of Daugavpils Himvolokno plants	-	12	12	- " -
TEC of Bolderaja KPPD	-	12	12	- " -
Marupe TEC in Riga	-	12	12	Installment of a gas turbine in the existing boiler-house
Andrejsala TEC in Riga	-	24	24	Installment of a turbine in the existing boiler-house

3.6 Building of New Electric Power Plants

Coordinated solution of the electric power supply problem in Latvia is possible only by building new generating capacity as it is practically impossible to get electric power from the outside.

Guided by this, the development of the Latvian Power system by building its own electric power stations may proceed following on of the five variants:

Variant I	- building a new TEC in Riga (Riga TEC-3) with the capacity of electric power 750 MW and thermal energy 780 Gcal/h and a condensational electric station (CES) with the electric capacity of 1150 MW somewhere in Latvia
Variant II	- building Riga TEC-3 with a capacity as in Variant I, new TEC in Daugavpils and Liepaja with a capacity of 270 MW and 350 Gcal/h and a condensational electric station with a capacity of 830 MW
Variant III	- building Riga TEC-3 with a capacity as in Variant I, new TEC in Daugavpils and Liepaja with condensational extensions on the two last ones with capacities correspondingly 685 MW and 350 Gcal/h
Variant IV	- building a new CES with a capacity of 1900 MW on the territory of Latvia
Variant V	- building new TEC in Daugavpils (270 MW), Liepaja (270 MW) and Riga (750 MW, only in Scenario II), their work combined with the extended Riga TEC-2 to 6000 hours per year.

Due to a lesser consumption of fossil fuel in Variant V in comparison with the other variants the balances of capacity and electricy production are presented according to Variant V at the levels of electric power consumption in Latvia in the year 2005 15 million kWh (Scenario I, see Table 3.4-3.5), and 17 billion kWh (Scenario II, see Table 3.6-3.7).

The preference of this variant may be confirmed also by the fact that it meets sharply increased ecological requirement for the development of energetics in towns, higher reliability of heat supply to urban consumers, bringing the capacity closer to the centre of its consumption, which, in its turn, should reduce the losses of electric power for its transportation and investments into the building of electric networks.

Depending on the development rates of national economy, these balances allow to choose and discuss the possible variant of electric power development in Latvia, and then to use these data for carrying out optimization calculations in order to choose the sources of energy.

It follows from that:

- first of all, in Latvian it is necessary to carry out the extension of Riga TEC-2 by 500 MW. In case new enterprises of relatively high power consumption are set up in Latvia, then corresponding TEC should be near them,

- the questions regarding the sequence of building new TEC (in Daugavpils, Liepaja, Riga TEC-3 and a new large power source) should be decided in the context of energetics of the three Baltic countries and real structural changes of the national economy.

Table 3.4. Balance of electricity production, TWh (Scenario I)

	1985	1990	1995	2000	2005
1. Consumption of electric power	9447	10226	11000	12500	15000
2. Covering with proper electric power stations	4956	6643	5030	10713	13169
including:					
The Daugava cascade	2986	4496	2740	2740	2740
Riga TEC-1	555	482	500	780	780
Riga TEC-2	1290	1561	1600	5430	5340
Daugavpils TEC	-	-	-	810	1620
Block stations	125	104	182	318	318
Small HPS	-	-	1	4	10
Other new and renewable sources of electric power	-	-	7	25	45
Liepaja TEC	-	-	-	-	1620
Andrejsala TEC	-	-	-	96	96
TEC of RAF or CBK	-	-	-	600	600
3. (Import) of electric power	4491	3583	5970	1787	1831
The limit of a possible import			7100	7300	4700
including from Lithuania			4500	4300	2000
from Estonia			2600	3000	2700

Table 3.5. Balance of electric capacity, in MW (Scenario I)

	1985		1990		1995		2000		2005	
	in max. hours	in hours near max.	in max. hours	in hours near max.	in max. hours	in hours near max.	in max. hours	in hours near max.	in max. hours	in hours near max.
1. Electric loading	1891	1510	2020	1800	2160	1840	2500	2130	3050	2600
2. Supposed capacity of electric stations	1993	1993	2000	2000	2285	2925	2925	2925	3341	3341
including:										
The Daugava cascade	1463	1463	1463	1463	1529	1529	1566	1655	1574	1574
Riga TEC-1	122	122	129	129	129	129	129	129	129	129
Riga TEC-2	390	390	390	390	600	600	890	890	890	890
Daugavpils TEC	-	-	-	-	-	-	135	135	270	270
Block stations	18	18	18	18	25	25	73	73	73	73
Small HPS	-	-	-	-	0.6	0.6	4	4	5	5
Other NRSE	-	-	-	-	1	1	4	4	6	6
Liepaja TEC	-	-	-	-	-	-	-	-	270	270
Andrejsala TEC	-	-	-	-	-	-	24	24	24	24
TEC of RAF of CBK	-	-	-	-	-	-	100	100	100	100
3. The capacity of the loading not participating in the covering of the schedule	161	1466	56	1519	320	1739	90	1566	-	1574
4. Repairs and breakdown reserve of capacity on electric power stations	202	202	200	200	200	200	200	200	200	200
5. Capacity to be obtained from other power systems	261	1185	276	1519	395	1494	-135	971	-91	1033

Table 3.6. Balance of electricity production, TWh (Scenario II)

	1985	1990	1995	2000	2005
1. Consumption of electric power	9447	10226	11500	13500	17000
2. Covering with proper electric power stations	4956	6643	5126	11523	16169
including:					
The Daugava cascade	2986	4496	2740	2740	2740
Riga TEC-1	555	482	500	780	780
Riga TEC-2	1290	1561	1600	5430	5340
Riga TEC-3	-	-	-	-	3000
Daugavpils TEC	-	-	-	810	1620
Liepaja TEC	-	-	-	810	1620
Block stations	125	104	182	318	318
TEC of RAF or CBK	-	-	-	600	600
Andrejsala TEC	-	-	96	96	96
Small HPS	-	-	1	4	10
Non-traditional restorable sources of electric power	-	-	7	25	45
Electric power obtained from other power systems	4491	3583	6374	1977	831
The same excluding RTEC-3			6374	1977	3831
The limit of the import from neighbour power systems according to the agreement of the ministers			7100	7300	4700

Table 3.7. Balance of electricity capacity, in MW (Scenario II)

	1985		1990		1995		2000		2005	
	in max. hours	in hours near max.	in max. hours	in hours near max.	in max. hours	in hours near max.	in max. hours	in hours near max.	in max. hours	in hours near max.
1. Electric loading	1891	1510	2020	1800	2260	1920	2700	2300	3450	2900
2. Supposed capacity of electric stations	1993	1993	2000	2000	2308	2308	2060	3060	4091	4091
including:										
The Daugava cascade	1463	1463	1463	1463	1529	1529	1566	1566	1574	1574
Riga TEC-1	122	122	129	129	129	129	129	129	129	129
Riga TEC-2	390	390	390	390	600	600	890	890	890	890
Riga TEC-3	-	-	-	-	-	-	-	-	750	750
Daugavpils TEC	-	-	-	-	-	-	135	135	270	270
Liepaja TEC	-	-	-	-	-	-	135	135	270	270
Block stations	18	18	18	18	25	25	73	73	73	73
TEC of RAF of CBK	-	-	-	-	-	-	100	100	100	100
Andrejsala TEC	-	-	-	-	24	24	24	24	24	24
Small HPS	-	-	-	-	0.6	0.6	4	4	5	5
Other NRSE	-	-	-	-	1	1	4	4	6	6
3. Capacity of the loading not participating in the covering of the schedule	161	1466	56	1519	320	1739	90	1566	-	1574
4. Repairs and breakdown reserve of the capacity on electric power stations	202	202	200	200	200	200	200	200	200	200
5. Capacity to be obtained from other power systems	261	1185	276	1519	472	1551	-70	1006	-441	583

3.7 Development of Heat Supply Systems in Latvia

According to the calculations made above the growth of heat energy consumption was assessed to be:

(million Gcal)

	1985	1990	1995	2000	2005	2010
Total Consumption	30.9	32.5	34.6	37.2	40.2	42.9

Table 3.8. The structure of requirements of national economy branches of Latvia in thermal energy, million Gcal.

(a forecast of made at the beginning of 1990)

	1985	1990	1995	2000	2005	2010
Total	30.9	32.5	34.6	37.2	40.2	42.9
%	100.0	100.0	100.0	100.0	100.0	100.0
Including:						
industry	13.5	14.1	14.4	14.6	14.8	14.9
%	43.7	43.5	41.6	39.6	37.1	34.8
building	0.2	0.3	0.3	0.3	0.3	0.3
%	0.6	0.9	0.9	0.8	0.8	0.7
transport	0.4	0.4	0.4	0.4	0.4	0.4
%	1.3	1.2	1.1	1.1	1.0	0.9
agriculture (production needs)	0.7	0.8	1.7	2.4	3.0	3.6
%	2.3	2.5	4.6	6.5	7.5	8.4
municipal economy	14.0	14.7	15.5	17.1	19.0	20.7
%	45.3	45.3	44.9	45.5	46.8	48.1
other needs	1.4	1.4	1.4	1.4	1.4	1.4
%	4.5	4.4	4	3.8	3.5	3.3
losses in thermal networks	0.7	0.7	0.9	1.0	1.3	1.6
%	2.3	2.5	2.6	2.7	3.2	3.7
The same in % to the thermal energy consumption in the centralized heat supply systems	4.5	4.5	4.5	4.5	4.6	5.0

The structure of requirements of national economy branches is presented in Tables 3.8 and 3.9.

The actual consumption of thermal energy in the republic for 1989 was 29.3 - 29.5 million Gcal, which is by 7-8% less than calculated and by 5% less than in 1985, and it is also confirmed by the data on the consumption of furnace fuel.

At present possibilities of further expansion of main boiler-houses are analyzed in the schemes of heat supply for larger towns and regional centres, as well as technical possibilities of their expansion and installment of additional thermal equipment following earlier supposed development of production and housing.

Table 3.9. The structure of thermal energy supply in Latvia.

	1985	1990	1995	2000	2005	2010
Requirement, million Gcal	30.9	32.5	34.6	37.2	40.2	42.9
Supply, total, million Gcal	30.9	32.5	34.6	37.2	40.2	42.9
including from district heating sources, million Gcal	15.4	17.2	20.2	23.3	26.4	29.3
among them:						
from heat sources of Latvenergo (TEC and regional boiler-houses), million Gcal	7.7	8.6	10.9	13.4	15.8	17.8
from heat sources of other ministries departments, million Gcal	7.7	8.6	9.3	9.9	10.6	11.5
centralization coefficient of heat supply, %	49.8	52.9	58.4	62.6	65.7	68.3
Share of heat sources of Latvenergo in the supply of thermal energy, %	24.9	26.5	31.5	36.0	39.3	41.5
Share of heat sources of other ministries and departments in the supply of thermal energy, %	75.1	73.5	68.5	64.0	60.7	58.5

Generalized analysis of the existing situation of heat supply in the republic testify the following:

- the structure of heat consumption in the republic is characterized by a great specific weight of the heat consumption for heating, ventilation and hot water supply (about 85-90% from the total heat consumption). As a result of this the heat consumption greatly depends on weather conditions. Taking into consideration, that approximately 70% of the total furnace fuel consumption goes to heat supply (about 40% in the former USSR) this fuel consumption level, too, depend on weather conditions;
- the mean productivity of a boiler in a boiler-houses are almost four times less than average in the former USSR (0.43 and 1.76 Gcal/h, correspondingly), the mean productivity of boiler-houses is low, too (about 1.54 Gcal/h of productive and about 1 Gcal/h of heating boiler-houses). As a result of this, labour productivity of the yearly output, transportation and distribution of thermal energy in Latvia is about 0.7 thousand Gcal/ per person, which is significantly less than the average indices for TEC (approximately 12 thousand Gcal/per person) and in systems with big regional boiler-houses (about 6 thousand Gcal/per person). When fuel is burnt non-economically (specific fuel consumption in solid small boiler-houses is up to 50% higher than in big regional boiler-houses), the ecological situation of populated areas deteriorates. In the overwhelming majority of existing solid fuel heating boiler-houses there are installed physically and morally outdated cast iron water heating boilers of the types »Minsk«, »Universal« and so on. They are characterized by high specific consumption of fuel, reaching sometimes 260-300 kg ce/Gcal.

Besides the low economic efficiency, the small solid fuel boiler-houses with low chimneys (not taller than 20-30 m) are also characterized by their negative effect on the environment.

The fraction of the heat consumption supplied as district heat in Latvia as a whole, is assessed to be about 0.5; in municipal economy about 0.33 (in towns and townships about 0.57 including heat supply from inter-block and group boiler-houses, in rural areas about 0.04).

Yet now, considering the changes of the conception in housing and structural changes to be expected in industrial production in the period till 1995 no increase in heat energy consumption in production is expected, but taking into consideration the rise of prices and economical measures - the consumption of heat in housing will become stabilized during this period.

3.8 Fuel Supply in Latvia

In 1989 about 10 million tce (1 tce = 29.3 GJ) of furnace fuel and light oil products were consumed in Latvia. The balance for oil products is shown in Table 3.10.

Approximately 435 thousand tce was consumed for producing electric power (4.4% from the total fuel consumption and 5.8% from the consumption of furnace fuel), approximately 1.1 million tce used for technological purposes in industry (1.1% from the total fuel consumption and 15% from the consumption of furnace fuel).

It should be noted that because of weather conditions and in sufficient supply of liquid fuel the total fuel consumption in 1989 was approximately by

Table 3.10. Balance of oil products 1990 (1000 tce).

	Total	Industry	Building	Transport	Agricul-ture	Household	Commer-cial
Diesel fuel	1116	112	56	564	202	178	4
including boiler-furnace fuel (BFF)	180	3				177	
Gas turbine fuel	79			79			
Engine fuel	83	10		60	4	9	
including BFF	4	4					
Gasoline	904	2	28	626	54		194
Aviation gasoline	2			2			
Technical petroleum	18	15			3		
Light petroleum	5			2			3
Aviation petroleum	105			105			
Total	2312	139	84	1438	263	187	201
including BFF	184	7				177	
without BFF	2128	132	84	1438	263	10	201
Fleet heavy fuel oil	197	99		97		1	
including BFF	98	98					
Furnace heavy fuel oil	764	263	6	471	2	21	1
including BFF	194	173				21	
Total heavy fuel oil	961	362	6	568	2	22	1
including BFF	292	271				21	
without BFF	669	91	6	568	2	1	1
Total	3273	501	90	2006	265	209	202
including BFF	476	278				198	
without BFF	2797	223	90	2006	265	11	202

10% lower than in 1985, including furnace fuel - by 5.5%, diesel fuel, petrol and other kinds of light oil products - by 20%.

Natural gas comes to the republic from the deposits in the north of Tyumen Region through the system of gas-pipes north of Tyumen Region-Uhta-Torzhok. From Torzhok most gas is transported through the gas-pipe Torzhok-Valdai-Pskov-Riga, another part of gas after the completion of the linear part of the gas-main Minsk-Vilnius comes through gas pipes Torzhok-Minsk, Minsk-Vilnius (Sirvintos), Sirvintos-Panevezys, Panevezys-Riga.

At the time being liquified gas has been supplied to Riga, Daugavpils, Jelgava, Jekabpils, Livani, Sigulda, Liepaja, Jurmala, Saldus, Bauska, Ogre, Cesis, Broceni, Vangazi, Kalnciems, Iecava, Kekava, Sauieski, Ligatne etc. In the nearest future it is supposed to gasify Valmiera, Aluksne, Olaine and other towns and townships. Attention should be paid to extraordinary low gasification rates of object in towns which leads to continuous insufficient use of capacities of the objects of the gas transporting system-gas-mains and the gas distribution stations. This refers, first of all, to the towns like Cesis, Daugavpils, Jekabpils, as a result the efficiency of such capital work falls as building gas-pipes and gas distribution stations to the corresponding populated areas.

One of the principal features of Latvian gas supply system is the existence near Riga of a powerful Incukalns underground natural gas reservoir, which allows to increase the gas supply reliability of the republic and provide most consumers of the republic with natural gas in case of sharp decrease in its supply to Latvia.

The basic parameters of gas tranporting system on the territory of the republic are characterized by following figures:

- total length of gas-pipes (in one-thread variant) - about 1000 km, including:
  with a conditioned diameter of 700 mm - 431 km
  with a conditioned diameter of 500 mm - 360 km
  with a conditioned diameter of 350 mm - 139 km
- total number of gas distribution stations, pieces - 46
- active capacity of Incukalns, billion m^3 - 2.1
- maximum daily discharge of natural gas from Incukalns, million m^3/day - 26

The supply of the republic with liquid fuel is carried out from 16 oil bases of »Degviela« Union in Riga, Olaine, Cesis, Rezekne, Saldus, Stende, Tukums, Jelgava, Liepaja, Madona, Valka, Valmiera, Ventspils, Gulbene, Daugavpils and Jekabpils.

Notably that from the 16 oil mentioned only Riga oil base and the Milgravis enterprise have not only capacities for light oil products but also for mazut (10 and 4 thousand m^3). Only light oil products, including furnace fuel and motor fuel.

The largest mazut oil situated near the railway is at Aglona (for fuel supply to the Preili Cheese Plant and other objects in Preili region), at Skrunda (for fuel supply to the objects of Communications Ministry at Kuldiga) at Cesvaine (for mazut supply to the boiler-house of the Cesvaine dairy and boiler-houses at Madona), it is envisaged to build a mazut base at Ludza in the nearest future for fuel supply of the town's boiler-house and other objects in the region, including village Felicianovo. Besides, as distributing railway mazut bases serve the mazut oil of many enterprises, such as the base of darainage pipes at Kuprava, the Spartak Plant in Jelgava, railway depot at Gulbene, bunkering enterprise in Ventspils, Latvijas Balzams Production Union at Jaunpagasts village (Virbi) in Talsi region, Valmiera Meat Combined Plants, the asphalt-emulsion plant at Tukums, the town boiler-house at Cesis etc. Their further development is in many cases limited, and this creates additional difficulties in fuel supply of the corresponding object. Because of this, quite a tense situation has developed in a number of regions with the mazut supply to boiler-houses, for instance, in Kuldiga, Talsi, Aluksne, Liepaja and other regions. Through the two already mentioned oil bases in Riga and Olaine in 1989 2188 thousand former of mazut were transported.

The supply of solid fuel boiler-houses and other objects without railway side-lines is effected from 8 interregional production enterprises.

The existing policy of price-formation did not give a possibility to undertake the normal work of a fuel supplying organizations, as they all were not profitable.

A significant change of fuel prices is expected now that will enventually cause a significant rise of expenses in Latvia for the supply of fuel-power resources, and, consequently, will give a new impetus to the work and rational use of power resources.

In 1990 the fuel-power resources were supplied to Latvia from 8 republics of the Soviet Union for a total sum of 0.729-1.22 billion roubles.

The possibility to use different kinds of fuel under a market economy open a way to change significantly the structure of the Latvian fuel balance.

The transition to market relations and liquidation of the monopoly of separate enterprises in the republic on certain kinds of products and restoration of the competition between them promotes the role of economical factors in the functioning of these enterprises and striving to lower annual production expenses including expenses on fuel-power resources consumed. At the same time it should be emphasized that this transition is also connected, by the way, with the specification of fuel resource prices, their reduction to real values, corresponding to real expenses on the output, processing and transportation of different kinds of fuel.

Fuel, prices have already increased considerably.

Due to rise of fuel prices at the enterprises, the welfare of which will fully depend on the economical results of their work, the interest of the enterprises will supposedly rise for more rational utilization of fuel resources, including the substitution for less deficit and more cheap kinds of fuel, as well as in cutting fuel consumption.

Under these circumstances it seems purposeful:

- to calculate the expenses necessary for the storage and transportation of solid, liquid fuel and natural gas in Latvia with the purpose to determine a substantial increase of trade prices on the fuels in which these expenses are not taken into account. By the way, these prices should include working expenses without solid and liquid fuel from which fuel supply to objects without railway side-lines is carried out;
- to find the economically purposeful zones to be supplied by natural gas, depending on the size of the fuel consumption and the length of gas-pipes;
- to make environmental assessments the principal positions for stating of particular fuel-consuming installations, considering parameters such as transportation conditions, ecological situation in the region of their placement, the circle of objects joined to them, as well as measures that should be carried out in the particular equipment for burning of ecologically dirty kinds of fuel like mazut with the aim to provide acceptable concentration of their harmful discharge into the atmohsphere of the inhabited area.

Considering the economical indices of the output, transportation, distribution and consumption of various kinds of fuel, it seems necessary to correct the structure of the future fuel balance. In this respect much depend on the future fuelprices. In case the fuel is purchased at world prices, the problems connected with the limited amount of resources will not be so essential and will go to the background. As the most prominent will remain the problems of economical character on the basis of which the problems of fuel transportation from eastern or western markets may be solved, including the problem of creating in Latvia of a modern oil processing plant with the deep processing of oil and its desulphurization.

The basis of this work should undoubtedly be corrected future requirements of fuel, determined by using a new model of national economy.

In the present conditions when the commanding-distributing system is abolished and transition to marketing relations take place the basis for a future fuel balance structure should be formed from economical indices of the output, transportation and consumption of various kinds of replaceable fuel. It seems that the earlier determined fraction of natural gas in the total consumption of furnace fuel up to 84% (up to 73% of the total fuel consumption) is obviously overestimated. It is meant that the supply of natural gas to small rural places with insignificant requirements of heat and fuel, is not economically justified. Boiler-houses using furnace fuel and coal may sufficiently succesfully compete with gasfired boiler-houses in such places.

In this connection one may suppose that simultaneously with the lowering of the fraction of natural gas in the future total consumption of furnace fuel (as compared with the earlier accepted) to about 60 + 65%, the fraction of coal may rise-up to about 15-20% and the fraction of furnace mazut fall to 9-12%. The fraction of local kinds of fuel by this may be approximately 7-8%.

As a result of unclear perspective for the development of the national economy including the fuel-energetic economy in Latvia there is a low probability that earlier forecasts for the future fuel requirements will be correct. Moreover, different organizations will have a different view of the future fuel requirements.

3.9 Assessment of the Development of Heat and Fuel Supply Systems

At present when there is no reliable information about the prospects for the development of the national economy in Latvia, a correct strategy for heat and power development is practically impossible. The information, accessible now, allows only to judge about the main trends in the heat and power supply development.

Further development of centralized heat supply in towns, where the use of resources that are necessary for this purpose may give the most significant and quick effect with simultaneous upgrading of the heat power system.

Under market relations and rather high tariffs to be expected on thermal energy in systems of centralized heat supply the criterion for the efficiency of joining this or that object to the heat supply of the town should not be abstract economical efficiency. The purposefulness of various heat supply variants (centralized or decentralized) should be confirmed by the results of technical and economical calculations taking into account the general circumstances of heat supply in the region where the given object is situated and the ecological situation.

This is the principle that reflects the new conditions for enterprises and their economy.

Another background is the changes in the structure of the energy complex of the former USSR which creates problem with the fuel supply, the lack of electric capacity in Latvia, and the lack of free convertible currency for the purchase of fuel beyond outside the former Soviet Union, for use, first of all, to meet the requirements of production in electric and thermal power.

Thus, in these circumstances the use of additional amounts of natural gas to produce electric power (approximately 80-90 million m^3 for 100 MW of thermal electric capacity) on the new gas fueled TEC may lead to a certian limitation of the area in Latvia supplied with natural gas, and a rise of the coal consumption in corresponding volumes.

In correspondance with the heat supply scheme of Riga the purpose of which is the development of centralized heat supply of the city it is envisaged to expand the TEC with one or two steam-gas blocks in the aggregate of a gas turbine, T-180/210 - 130, a steam boiler with a capacity of 670 t/h and a gas turbine GTZ-45. The first block is to be installed in the next five-year period.

In variants it is supposed to discuss the question about the construction of Riga TEC-3 on the left side of the Daugava with two or three similar steam-gas blocks which will enable to limit the designed capacity of the local boiler-houses at Marupe with 200-300 Gcal/h and to bring local boiler-houses of the left-side part of Riga to a peak condition of work with sharp lowering of their negative effect upon the environment. The construction of TEC-3 under favourable conditions may really start in 1994-1995 with the introduction of thermal capacities after 1996.

As to the conditions of electric power supply, a rather steady trend may be to change boiler-houses to combined heat and power plants by e.g. installment of steam turbines with a counterpressure of type »P« gas turbines which, in some way may facilitate the solution of local electric power supply problems.

The installment of small steam turbines in the existing boiler-houses at medium steam parameters with a capacity of 4-12 MW this is possible in case there are boilers of 3.9 MPa; the installment of turbines in boiler-houses with the capacity of 2.5 MW is possible at low parameters of steam in case there are boilers of types DKVR and DT for 1.3 MPa in boiler-houses. Preliminary installment of such turbines is envisaged with a total capacity of about 80 MW.

When discussing the questions of gas turbine installment, one should not forget that serial turbines of the former USSR have large dimensions, therefore, in many cases, imported machines with smaller dimensions from other countries are preferred.

The efficiency of heating systems will directly be affected by cutting the specific heat consumption through the reduction of heat losses to the environment, by reducing specific norms for heat consumption. These questions are to be discussed in detail in the nearest future.

To start this work, the appropriate normative base is to be created and the heat consumer's psychology changed.

3.10 Resources of Wood Waste and their Application in Power Production

At the present moment the state and agricultural facilities obtain about 2.5 million cubic meters of round timber wood for burning. Besides, according to approximate evaluations, the rural inhabitants themselves prepare around 1.8 million cubic meters of wood for house heating. This usage of round timber wood is not reasonable at the present circumstances, when wood is one of the main export goods of Latvia. It is to be seriously stream-lined. Most wood resources for heating correspond to the requirements that they would be directed to more efficient aims e.g. as wood chips. On the other hand, in forests there are enough remains in felling areas and wood-waste that could be gathered by modern technologies and used for energy purposes. Taking into consideration possible problems in the Latvia heat supply through liquid and gas fuel reduction, we ought to increase the wood share of our energy balance. At present the contribution of wood to the heating requirements has considerably fallen year by year, i.e. from 29 percent in 1965 to 14 percent in 1989. Resources of low-quality wood are remarkable and they can be increased significantly without doing any harm to our new tree stands. By gathering all rotting and dying trees together with small ones, forests condition may be improved.

How big are the wood fuel resources in Latvian forests and what are they formed of? First, it should be pointed out that state farms do not, year after year, extract the permitted volume of timber from the forest stands, especially, of low-quality foliage ones. It might be possible to prepare about 800 thousand m^3 of fire-wood in addition (see Table 3.11).

During felling procedure the timber in new marketable forest stands, branches and treetops are burnt up or laid down into the transportation roads of felling areas where they get crushed by the wheels. It provides a more stable transportation process on overdamp soils, but in many cases it is an obstacle to impede on normal forest regeneration. A modest estimate gives that in forest felling areas we can acquire about 532 thousand m^3 of wood fuel.

On the sites of timber logging each year some 555 thousand m^3 of unmercantile wood is left rotting. It could be collected and processed into wood chips applicable as fuel.

When realizing agricultural melioration tasks with overground fields recreation, every year we can acguire about 539 thousand m^3 of bush wood. Otherwise, today it is largely pushed together in heaps, burnt or left to rot. The amount of this wood waste may be practically collected by using well-known technologies since their cost is not so high.

In forests over the whole territory of Latvia there are dying and uncollected wood totalling of 1.4 million m^3 in the sites of sanitary forest stands. In former years rural people collected this amount and burn in their ovens.

The technology of stump processing has not yet been developed neither in this country nor in the Scandinavian countries or other developed countries. Therefore these quantities of 364 m^3 can not be included into the fuel balance. But even more noteworthy quantities of wood waste rot on the fields of over 800 saw-mills and near small cutters of agricultural production enterprises. A part of it is used for catlle-freeding, but more than 200 thousand m^3 of chips and small cuts are transported to dustheaps where it rottens. It could most easily be used as energy supply for boiler houses.

Thus, all together, Latvia has the possibility practically to add more than 2 million m^3 prepared as wood energy resources that may substitute about 600 thousand tons of coal equivalent, and it is already an important addition (around 5%) into the heat power balance (see Table 3.11).

What is the problems to make efficiently use of these wood energy resources? In the first place it is our price policy. Until now it was much easier to use diesel fuel, gas or even electric power that required less work consumption, as well as money expenses. Another serious drawback is the fact that our burning equipments are not suitable for burning wood. The best technology for the use of the wood waste would be wood chips equipment. Latvia does not yet procedure mobile chipping machines, they have to be purchased from the Scandinavian countries. To be sure Scandinavia produces different chipping machines of many kinds; they could be applied to various field-work tractors available here.

Stationary chipping machines for sawn remains and round timber chipping are produced in the former USSR and they can be purchased in the respective factories.

In solving the problem, two alternative variants are worth considering. One is that Agricultural production enterprises cooperatively buy wood chipping machines because their productivity is so high that during a month they produce around 10000 m^3 of wood waste that is necessary for burning in the boilers.

The second alternative is that the forestry industry and their enterprises obtain mobile chipping machines. The wood chips could then be brought to the boiler units of agricultural production enterprises.

The density of the wood resources is quite different in different regions of Latvia and, therefore, it should be necessary to transport wood fuel between seperate regions (see Table 3.12).

Each type of wood requires its own preparation unit and technological scheme. It is compulsory with a storage for the cut wood or chips during summer months when moisture naturally falls to 30-35%, taking into consideration that calorific value at 30% of moisture is 3342 kcal. per kg, but at 60% it is 1374 kcal. per kg. A basic factor influencing chip preparation treated economically is the level of mechanization. By the way, the key operation is branch cutting and transportation. On thinning trees by motorsaw and collecting branches manually, work consumption and expenses are big. The most optimal technology would be that one with a mechanized branch sawing.

Transportation of timber refuse and processing of it in stationary sites increase expenses by 10-15% as compared with chip transportation to customers straight from the primary chipyard. It is economically justified to trail and pre-process felled trees with modern branch sawing machines. To collect the branches from sanitary sites and to transport them seperately is not profitable.

Production of wood applicable for burning from new tree stands is very work-consuming and at present it is economically unprofitable, but as the whole biomass technology is developing. Bush processing during melieration on areas could be treated like a forest sanitary work with a small motorsaw. In Lithuania a bush gathering mashine is modelled on the basis of the tractor K-700, but it is not yet in serial production. Experience in bush collecting and chip processing has been gained from a French firm »Simaf«. Finnish firms could supply special machines for tree-top and biomass chipping and for chipping of coarser wood, as a machine TT-1000 TU of the firm »Valmet«.

Practise shows that a higher capacity to burn wood waste is observed with trunkway furnaces with tilted or horizontal beams. In the bunker of the trunkway a reserve of fuel is stored. It provides fuel transport to a furnace. The volume lessens the flow of air during fuel loading and the regularity that is lacking to manually loaded furnaces.

3.11 Straw as a Fuel Reserve in Latvia

In the former Soviet Union economical chaos results in a reduction in oil and coal extractions. The fuel crisis in Latvia has become stronger due to the recent 10 years practice to diminish the use of biomass fuels. Latvian taxation also does not promote the act of using domestic fuel, but promotes import that is expensive. These local fuel resources are considerable in Latvia.

Table 3.11. Unmercantile wood resources in Latvia/1000 m^3

No.	Types of unmercantile wood	Total resources	Currently used resources	Resources not used	Resources not used 1000 tce
1	Firewood	3100	2300	800	213
2	Remains of logging site	532	–	532	141
3	Bushes (during melioration)	539	–	539	143
4	Unmercantiles during forest sanitary hewing	555	–	555	147
5	Average natural dying-out of forest	1400	600	800	213
6	Dust of sawmills	200	–	200	76
7	Stumps*	364	–	364	97
	Total	6690	2900	3790	1030
	Practically possible to acquire			2120	590

* Concerning stump utilization, there are several viewpoints.

Table 3.12. Wood fuel (not used) balance in the different regions of Latvia (1000 m^3) for group 1-4 in Table 3.11.

Economical regions	Firewood	Felling refuse	Bushes	Unmercantile wood	Total*
Daugavpils	95	44	92	19	250
Jekabpils	209	112	77	107	505
Gulbene	148	81	44	73	346
Liepaja	64	54	49	79	246
Rezekne	32	27	85	13	157
Riga	81	89	72	126	368
Valmiera	150	95	95	103	346
Ventspils	21	30	25	35	111
Total	800	532	539	555	2426

* In practise it is possible to process about 60%, i.e. about 1350 thousand m^3 of wood.

In order to draw conclusions and to start applying these fuel types it is necessary to estimate the resources. The straw resources are evaluated in the follows.

Cereals in Latvia take up 43% of the area used for agriculture. Due to the straw feeding capacity being low and for its local importance there are no precise data on straw amounts in the regions. But the annual grain yield and the average of one ha harvest are precisely known. The ratio of grain harvest to straw amount differs in a greater degree with the harvesting way than with a cereal variety. Moreover, this ratio in European countries (i.e. straw amount to one ton of grains) reduces as a result of selection and a high cultivation level handled for the last 30 years, the yield productivity has increased from 24 to 44 hectakilogramme (hkg)/ha. In Latvia the cereal yield of the last years had an average of 21 hkg/ha. It is presumed that for barley, wheat and oat straw the grains ratio (when a combine harvester gets used) is 0.75-1, but for rye 0.9 to 1.0. This is the basis of the following calculations.

Concerning the question about what Latvia overall lands bring as an average grain yield, it can be said respectively that one resident needs about 250 kg of grain a year to maintain oneself with bread and bread products. We must add the part of concentrated feed as a must for milk, eggs and meat production. That makes around 550 kg that are necessary per persson annually. The number of inhabitants in Latvia are 2600 thousands, then it is necessary to have about 1.43 million tons of grain, and the collected amount of straw must comprise 1.073 million tons ($= 1.43 \times 0.75$) and no less, while rye and wheat straw together must be about 470 thousand tons. As it is seen from the data of Table 3.13, this level in straw production of the former years is again kept. If Latvia plans not only to supply its residents with bread, milk, meat, eggs but also to do trade of agricultural products, then grain yield have to be raised up to 2 million tons a year, i.e. the average cereal crop must be increased from 21 hkg/ha to 31 hkg/ha. Such advice was also given by the scientists of the totalitarian regime. Following the world practise it should be mentioned that if it is otherwise then the cereals will not be able to compete. Thus, during 2-5 years it can be expected that the straw crop in Latvia will increase up to 1.5 million tons a year.

In Table 3.13 there are data of straw yield in Latvia within the period from year 1940 to 1989. In the present period, as to straw consumption, the ministry of agriculture has precise data of the first half of the 80-ies. The registration in other years was not very exact and explicit. However, in the years when the account is done, it is not known where 200-300 thousand tons of straw has been used. This unaccounted part may be plowed down, rotted, burned or used for some other purposes that are less important.

3.12 Peat Resources in Latvia

Peat bogs occupy 9.9% of the whole territory of Latvia, peat resources comprise 410 million tons at a definite moisture ($W = 40\%$). By asserted standards peat can be use as fuel both with low and transitory degree of decomposition higher than 10%, as well as at the highest degree of decomposition above 15%. Using the Latvian Land Reclamation Improvement and Design Institute data of the collection on peat resources (issued in 1980) and knowing the actual volume of peat extraction during the last 11 years, it has been calculated that air-dry peat resources applicable for burning in industry and coming from the bogs of areas with larger than 100 ha approximately constitute 194 million tons.

Table 3.13. Straw resources and the expenditure in Latvia by years (through the calculations by using barn weight in thousand tons).

1000 tons	Straw type	1940	1960	1980	1983	1985	1989
	Rye (winter crops)	435.6	256.4	160.2	238.5	320.0	470.0
	Wheat (winter crops)	89.1*	72.0*	162.4	237.6		
	Barley	123.5	88.4	509.6	432.2	590.0	600.0
	Oat	328.5	29.2	118.5	141.7		
	Total	1046.7	443.6	950.7	1050.0	910.0	1070.0
	Used according to data of Agriculture ministry						
	in fodder			340	605	584	729
	in litter			49	115		
	in construction work			246	125	59	
	in processing			35	20		
	Total			670	865	643	729

In the post-war period good success in power industry and municipal service, as well as in industrial heating needs was gained by making use of peat in pieces and mill-peat. Thus, in 1958 we produced 820 thousand tons of peat in pieces, but in 1971 there were 2136 thousand tons of milled peat burned. In 1991 there was just 1 thousand tons of peat in small pieces and 284 thousand tons of milled peat burned. Such a slowing down at peat extraction is due to:

- a tendency to substitute peat with the other rather cheap but imported fuel types as gas, coal, mazut;
- a shortage of peat resources at big peat extraction sites formed in the 50-ies and 60-ies.

So in 1991 all the peat factories had an output of 284 thousand tons of milled peat. The existing capacity (320 thousand tons) are used 90%. The consumption of milled peat was planned this year as folloows:

107 thousand tons for boiler houses of peat factories,
70 thousand tons for production of peat briquetts,
30 thousand tons for boiler house of the Livani biochemical plant,
5 thousand tons for Jekabpils reinforced concrete plant,
50 thousand tons for Riga TEC-1 as a reserve fuel.

It is expected that between the years 1991 and 2005 milled peat capacities will reduce over all exploited peat sites from 320 thousand tons to 80 thousand tons.

In order to increase the amount of burning milled peat extraction for energy purposes, it is possible to make use of peat deposits of transition type bogs. Such peatbogs could be 25 deposit sites with airdry burning peat resources of 43.0 million tons. Besides, according to the data of Latvia peat estimation papers, it is determined that there are 213 peat deposts of moss type. Their peat decomposition degree is above 15% and with an industrial area exceeding 100 ha, this resources of peat comprises 146 million tons. It should be mentioned that rather big reserves of peat applicable for burning can be found in moss-type swamps, in their deepest layers, i.e. in the depth of 1.5-2.5 m under the layer of litter peat. Such bogs may be utilized in a combined way extracting agricultural and peat for energy purposes.

Concluding, it is seen that the peat resources, when taking them into account in planning the utilization of it for power needs in Latvia, are considerably big. When used in industry with the present technology and machinery, around 100 million tons of peat could be produced out of the total resources in Latvia exceeding 190 million tons (by calculation with an equivalent humidity).

3.13 Energy Saving Potential in Latvia

The energy savings potential in Latvia by the levels of economy and replacement of fossil fuel for the period 1990-2015 were assessed as shown in Table 3.14 (in million tce):

Table 3.14. Energy saving potential in Latvia.

(A forecast from the beginning of 1990)

Million tce	1995	2000	2005	2010	2015
Total economy	0.680	1.360	2.100	3.350	4.170
including:					
improving interbranch and internal structure	0.180	0.680	1.160	1.850	2.110
the use of energy-saving technologies, and measures	0.500	0.680	0.940	1.500	2.060
Total replacement of fossil fuel due to the use of new renewable energy sources	0.017	0.041	0.074	0.126	0.230
Total savings + NRSE	0.697	1.401	2.174	3.476	4.400

In the period from 1992 till 2000 quite a remarkable share of the potential will probably be reached by using power-saving technologies, a gradual transition which has already started now. It should be noted that only up to 12% of the industry has the necessary technical level including power capacity of production. The total savings would reduce the total energy consumption by 20% in 2005 and 35% in 2015.

The row in Table 3.15 showing the potential for the use of energy-savings technologies is disaggregated by energy carrier in Table 3.15.

The structure of the Latvian industry is so that the potential energy savings is not to be made at a few factories with high saving potentials the main part - about 80% according to experts - is made up of many low-potential savings.

The result and possible use of energy saving technologies in Latvia was determined for the first time in 56 towns (6 cities of republican subordinance (Ventspils, Daugavpils, Jelgava, Liepaja, Rezekne, Jurmala) and 50 towns of regional subordinance). The data of the calculations considering a real expected amount of means for the investment of energy-saving measures are presented in Tables 3.15. Considering the complex character of the measures taken to save energy in Latvia, where the decisive is the territorial principle in the approach to the solution of the problem when, defining the output and possible application of savings of a particular town or rural populated place, all enterprises on the given territory are taken into account irrespective of their subordination.

The methodology of forecasting the output and application of savings for a town and for populated areas is developed using electronic calculators on the basis of technical and economical indices of 17 real heat supply schemes of towns and populated areas of Latvia with a complex use of energy savings. The methodology is reduced to a nomogram by which, if the total heat consumption for the town is known, it is possible to determine the supposed savings and investments by application of the savings nomogram (see Figure 3.2, the curves Q_{econ}, B_{econ}, and K_{econ}). When using the nomogram, corrected coefficients are used that consider the industrialization degree of the town.

When determining the total amount of energy savings (Table 3.15) it was considered that a certain additional consumption of electric power is necessary for the technologies which is excluded from the total result.

Calculations were done for the possible saving of power resources separately in each sector of the society.

Market relations will bring essential changes into the electric power supply, because a particular consumer will be interested not in an abstract economical effect but in concrete saved means for the heating or power supply. In these circumstances state functions will be directed mainly to investments into energy saving technology with relatively low specific fuel and electric power consumption, training the corresponding personnel, ensuring structural changes in production and improvement of the ecological situation.

Table 3.15. Fuel savings by the use of energy saving technologies, by energy carrier.

Kind of energy carrier	1995	2000	2005	2010	2015
Furnace fuel, thousand tce	151	300	450	600	750
Electric power, GWh	270	570	890	1210	1530
Thermal energy, thousand Gcal	190	470	800	1230	1660
Light oil product, thousand tce	20	40	80	150	2120
Total thousand tce	500	600	940	1500	2060

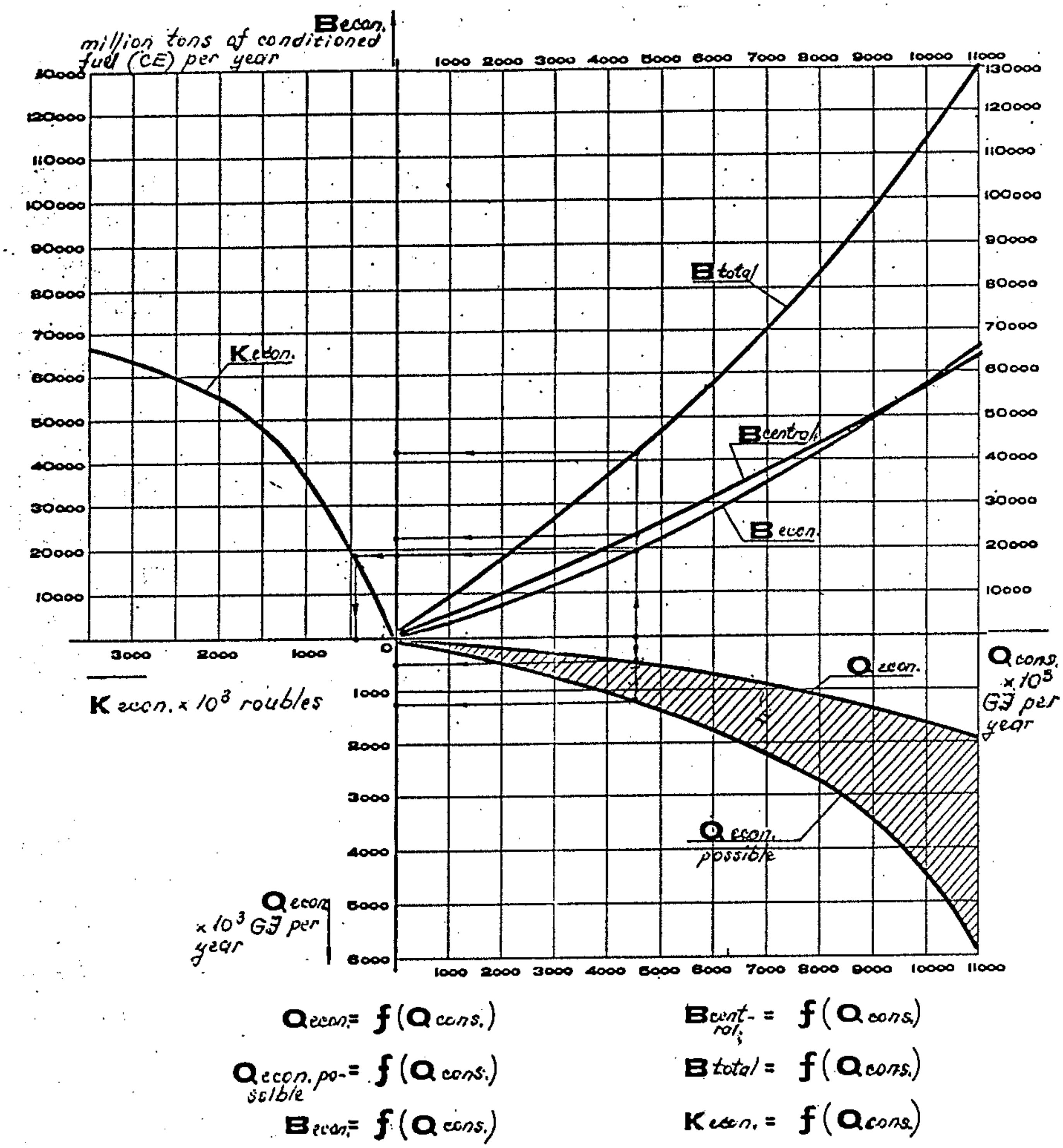


Figure 3.2. A nomogram for the determination of enlarged technical and economical indices of complex use of energy savings in towns and populated areas. (Q = heat consumption, B = energy savings, K = investments)

Therefore it will be necessary in the future to work more seriously on all these questions, this will require certain means, time and a joint methodological approach at least in the three Baltic countries.

3.14 Improvement of the Management Structure

The fuel-power complex of Latvia is not a branch but a sub-structure of the national economy. It comprises the output and purchase, storage, transportation, processing and consumption of energy resources. A significant part of the complex is distributed among the branches of national economy. With an aim to improve the management of the fuel-power complex and energy savings, the State Fuel-Energetic Committee was formed in Latvia in 1988, which was reorganized into the Ministry of Energy in 1990. A restructing has recently taken place and energy is now under the Ministry of Industry and Energy.

LEA (Energy Development of Latvia) was established one year ago as a state company under the Ministry of Industry and Energy to promote a rational energy policy, energy conservation and the development of alternative energy resources.

Energetic certificates for industrial enterprises are being worked out, the methodology is close to completion. A data bank is being created comprising indices of progresive energy capacity of production in Latvia, preparatory work is done for the development of energetic standards of energy resources, technologies, machines, enclosures of buildings. A draft is discussed on rational use of energy resources.

3.15 Basis Factors in the Formation of a Latvian Energy Programmes

In conditions of deficiency of energy resources and the fact that fuel-energetic complex enters practically into all branches of national economy, an instrument is needed for the management of this complex. Such a function, alongside with the introduction of the economical mechanism in the corresponding legislation, may be fulfilled by the National Energy Saving Strategy (to 2005) which the Government of Latvia has established.

Latvia has some experience in the development of an energetic programme, yet within the limits of the former mechanism of the economy with disbalanced resources, the energetic programme had mainly a theoretical, illustrative meaning: the parts of the programme, particularly in the field of energy saving, were weakly connected with national economy. In developing a new energetic programme, it is necessary to adjusted its structure to the new conditions of the economy.

It is advised to form a working group for each subprogramme which should include specialists from different organizations, which also after the completion of the programme will care for its realization.

The National Energy Saving Strategy has the following subprogrammes:

1. Energy resources balance
2. Extension, reconstruction and modernization of the physical energy infrastructure
3. Alternative energy sources
4. Energy conservation

5. Research and development
6. Energy information system.

The content of the 6 sub-programmes is the following:

1. The balance of fuel and energetic resources. Calculation of future consumption of electric power, heat, fuel and the necessary operative reserve of fuel.
2. Construction, reconstruction and modernization of the energy infrastructure. The programme comprises planning, building as well as design work.
3. New and Renewable Sources of Energy (NRSE). This subprogramme reflects all the problems connected with the development and distribution of non-traditional energy sources including scientific development, designs, production, building adjustment their volume and terms.
4. Energy conservation. The contents of this subprogramme is analogous to that of subprogramme 3.
5. Research and Development work of the fuel energy complex development. Determination of the directions of scientific and technical work, the terms, necessary means, their sources and forms of organization of the work.
6. Information and software.

In the energetic programme a forecast for years 1995, 2000 and 2005 will be made.

3.16 Direction of Scientific Research Work

Under the circumstances of market economy essential changes must take place in the directions of the scientific research work in energetics.

Investigations should be in the priority directions of the development of fuel-energetical complex, which is most interesting for Latvia. This work is financed by the state budget (3.0 million roubles in 1990).

The work is in the following directions:

1. The development of non-traditional energy sources including the development of conceptual designs (schemes) of wind installments, small and micro hydro powder station, biomass equipment etc.
2. The development of new methods and means of energy saving.
3. The development of a new energy saving equipment and non-traditional energy sources.
4. The development of new measuring and regulating devices for energy carriers.
5. The development of standards for technologies, machines and materials of energy consumption.
6. The development of normative and methodical materials for energetics.
7. The development of conceptions and conceptual projects for power supply development.

Individual themes which are worked on during the year are coordinated by Ministries of Energy on the three Baltic countries.

3.17 Foreign Contacts

The first contacts with western firms show the technical backwardness of the energetics in Latvia regarding modern measuring and regulating equipment, unreliability of regulating electric drives for the auxiliary equipment of energetic appliances, lack of reliable equipment for non-traditional energy sources, hopeless backwardness in mastering the existing gas purification methods and so on.

Yet, due to the lack of free convertible currency, the purchase of advanced equipment, equipment for a control and account, not to speak of fuel or oil products is quite problematic.

In the case of cooperation between the three Baltic countries it would be purposeful to join efforts of three Ministries of Energy and coordinated the direction. That would exclude parallel actions, and the efforts would have a coordinate character.

This is particularly important in such directions as:

- investigation of territorial waters and the continental shelf;
- investigation of the possibility to use geothermal energy;
- a search of rational structures, wind turbines and turbines for small hydro power stations and so on:
- investigation of the questions of ecologically nature in connection with the energy system.

Possibilities of cooperation of the three Baltic republics present great interest also in creating new underground gas reservoirs, distribution of energy sources, determination of optimum structure of fuel-energetic balances etc. In this work, under conditions of market economy, we need help from the states which have already accumulated experience.

The experience of the Nordic countries will be very useful to us. Transfer of their technologies and know-how will help us in the reconstruction of our energy system.

3.18 Conclusion

1. Under the circumstances when the directions and rates of economic development in Latvia are not clear, from the methodical point of view it is important to develop a strategy for the advancement of such branches of fuel energy complex that take into account the possibility for energy consumption to grow at a low rate.
2. The low weight of local energy resources (85% of the fuel consumed is supplied from outside and only 50% of the electric power consumed is generated in the republic) orientates towards energy saving strategies in the economic development of Latvia.
3. The power economy in Latvia should mainly be orientated towards lowering the specific power consumption and introducing power saving techniques as the structure of national economy in Latvia together with replacement by non-traditional kinds of power resources.
4. The development of electric power system for the period untill 2005 is connected with a combined output of electric and thermal energy through building and expanding TEC's in Riga, Liepaja, Daugavpils etc. by using steam-gaseous aggregates. For a more rational use of fuel it is recommended to use electric generating equipment on low capacity ther-

mal sources and effective thermodynamic cycles when producing and converting energy. This strategy corresponds to a growth of electricity consumption to 15-17 TWh/year for 2005). At a slower growth of electricity consumption, now generating capacity may be introduced at a later time.

5. Heat supply in Latvia should develop based on large sources of heat supply (TEC), as well as by development of regional heat supply from smaller combined heat and power plants and, in addition to it, by developing new systems of decentralized heat supply.
6. Fuel supply of Latvia is developing by means of natural gas. Relatively well developed main gas-pipes and the existence of Incukalns Underground Gas Reservoir, as well as further development of this gas supply system, will enable to base fuel supply on natural gas also in the future. The newly developed system of the supply with oil products from the former USSR may ensure the supply to Latvia of light and other oil products. The expansion of the use of coal in Latvia is not purposeful due to the great distance of the coal-mining regions in the former USSR.

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Jørgen Fenhann

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This is the third report in a series of reports about the energy systems in the Baltic countries: Estonia, Latvia and Lithuania from the project »Baltic-Nordic cooperation in the field of energy and environment« financed by the Energy Market Group under the Nordic Council of Ministers.

The present report tries to illustrate the potentials for energy conservation in Lithuania and Latvia.

For Lithuania the material is based on the »National energy efficiency programme«, which was prepared in 1991. It documents that the energy conservation potentials are large, especially in the heating sector. In includes the views of the Lithuantan specialists of the best measures and strategic directions to restructure the energy system.

For Latvia similar material is not available but will be developed in the tasks described in the National Energy Saving Strategy which the Government has established. This strategy is described and thoughts about future developments had to be based on energy projections from 1990 which although they are rather high still reflects some of the future possibilities including a calculation of the energy saving potentials, also made in 1990. The section about Latvia also contain chapters of the wood, straw and peat resources.

Descriptors INIS/EDB

ENERGY ANALYSIS; ENERGY CONSERVATON; ENERGY CONSUMPTION; ENERGY EFFICIENCY; ENERGY POLICY; HEATING SYSTEMS; PEAT; POWER SYSTEMS; RENEWABLE ENERGY SOURCES; RESOURCE ASSESSMENT; STRAW; USSR; WOOD FUELS

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